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PEMBROKE DUXBURY KINGSTON

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ROUTE 53
CORRIDOR STUDY

EXISTING AND FUTURE CONDITIONS

PROBLEM IDENTIFICATION

RECOMMENDED IMPROVEMENT TACTICS

RECOMMENDED IMPLEMENTATION PLAN

Old Colony Planning Council
in cooperation with the
Metropolitan Area Planning Council

MAPC

1985

Route 53 Corridor Study
Pembroke/Duxbury/Kingston

UWP TASK 6000
Special Studies

December, 1985

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Table of Contents

I. Introduction 1

II. Existing and Future Conditions 3

A. Socio-Economic Characteristics 3

1. Population 3
2. Employment and Work Trips 3

B. Physical Condition of the Roadway 5
C. Traffic Volumes 7
D. Future Traffic Volumes 8

III. Problem Identification 11

A. Safety Issues 11

1. Introduction 11
2. Pembroke Intersections 11
3. Pembroke Corridor Segments 13
4. Duxbury Intersections 14
5. Duxbury Corridor Segments 16
6. Kingston Intersections 16
7. Kingston Corridor Segments 17

B. Operating Conditions 18

1. Introduction 18
2. Route 53 at Route 139 19
3. Route 53 at Route 14 21
4. Route 53 at Route 3A 21

IV. Recommended Improvement Tactics 25

A. Introduction 25
B. Route 53 at Route 139 25
C. Route 53 at Route 14 31
D. Route 53 at Route 3A 33
E. Minor Intersections 33

1. Introduction 33
2. Route 53 at Old Washington Street 40
3. Route 53 at Water Street 40
4. Route 53 at Pleasant Street 41
5. Route 53 at Congress Street 41
6. Route 53 at Franklin Street 41
7. Route 53 at Valley and Cross Streets 42
8. Route 53 at Summer Street and Kingston Way 42
9. Route 53 at Winter Street 42

F. Access Controls 43

G. Other Safety Issues 43

Table of Contents (cont'd.)

V. Recommended Implementation Plan 45

A. Introduction 45
B. Short Range Plan 45
C. Long Range Plan 45
D. Project Impelementation and Funding 47

*Appendix A Traffic Volumes and Intersection Turning Movement Counts 1985, 1990

Appendix B Accident Data, 1983-84

Appendix C Level of Service Analysis Worksheets and Data

Appendix D MUTCD Warrants for Traffic Signal Installation

*Appendices are contained in a separate bound volume

List of Tables

Table Page

1. Population Trends and Projections 3
2. Employment and Work Trips 4
3. Employment Characteristics and Projections 5
4. Present and Future Traffic Volumes 10
5. Pembroke Accident Summary 12
6. Duxbury Accident Summary 15
7. Kingston Accident Summary 17
8. Route 53/139 Level of Service Summary 20
9. Route 53/14 Level of Service Summary 22
10. Route 53/3A Level of Service Summary 24
11. Route 53/139 Signalized Level of Service Summary 30
12. Route 53/14 Signalized Level of Service Summary 32
13. Route 53/3A Alternative Level of Service Summary 34
14. Summary of Short Range and Long Range Improvement Plan 46

List of Figures

Figure	Page
1. Route 53 Study Corridor	2
2. Average Daily Traffic Volumes - 1985	6
3. Average Daily Traffic Volumes - 1990	9
4. Route 53/139 Alternative Lane Geometry	26
5. Route 53/139 Alternative Phasing for Traffic Signal Installation	28
6. Design Considerations for "T" Intersections	36
7. Design Considerations for "Y" Intersections	37
8. Design Considerations for Four-Leg Intersections	38

I. Introduction

High rates of residential and commercial development occurring in the rural coastal communities in Southeastern Massachusetts have led to a tremendous growth in motor vehicle traffic on major corridors serving this area. For Route 53 in Pembroke, Duxbury, and Kingston, the anticipated growth in traffic volumes over the 1970-1995 period will exceed that of most of the region's other important highways. Along with these recent economic developments and the newly generated increase in traffic volumes comes a greater demand on roadways serving the area, leading to a host of traffic congestion and safety problems.

The purpose of this study is to identify existing and future traffic and safety problems along Route 53 and to develop feasible improvement at spot locations that will alleviate these shortcomings.

Chapter II, Existing and Future Conditions, is a documentation of socio-economic characteristics, growth trends, and projections which in turn affect traffic volumes. Also included are an inventory of the existing physical characteristics of Route 53 and a measurement of vehicles using the facility. Based on previously developed growth factors, projections of future traffic volumes are made.

Chapter III identifies specific locations where congestion and/or safety problems exist. At major intersections, manual traffic turning movement counts were conducted during peak traffic periods. Mechanical traffic volume counts were also recorded along several segments of the corridor and its major intersecting streets. Capacity and Level of Service Analyses, traffic engineering techniques, were applied to the collected field data to determine congestion and delay problems. To assess safety conditions, accident records were researched at local police departments. The frequency of accidents at specific locations is measured against relative traffic volumes to determine if a hazardous condition exists.

Recommended Improvement Tactics for Route 53 on a site-by-site basis are presented in Chapter IV. Alternatives for improving traffic flow at key intersections are developed and analyzed to determine the derived benefits in terms of reduced congestion and delay. Also, alternative improvement measures that would enhance safety conditions and reduce accidents are developed. These recommended improvements are than presented in a short range plan for immediate implementation and in a long range plan for final implementation. Short range improvements are minor inexpensive projects such as improved signing. Long range improvements are capital intensive projects such as traffic signal installation and lane widening.

The Route 53 traffic study concludes with a suggested course of action for local elected officials to follow in initiating action on a highway improvement project. A strong local committment on behalf of the project will enhance its chances of being funded with state or federal assistance.

For the sake of convenience to readers and users of this document, the text and Appendix are bounded under separate covers. The text includes summaries of pertainent technical analysis and other field data. The Appendix has detailed worksheets of the technical analysis and other field data.

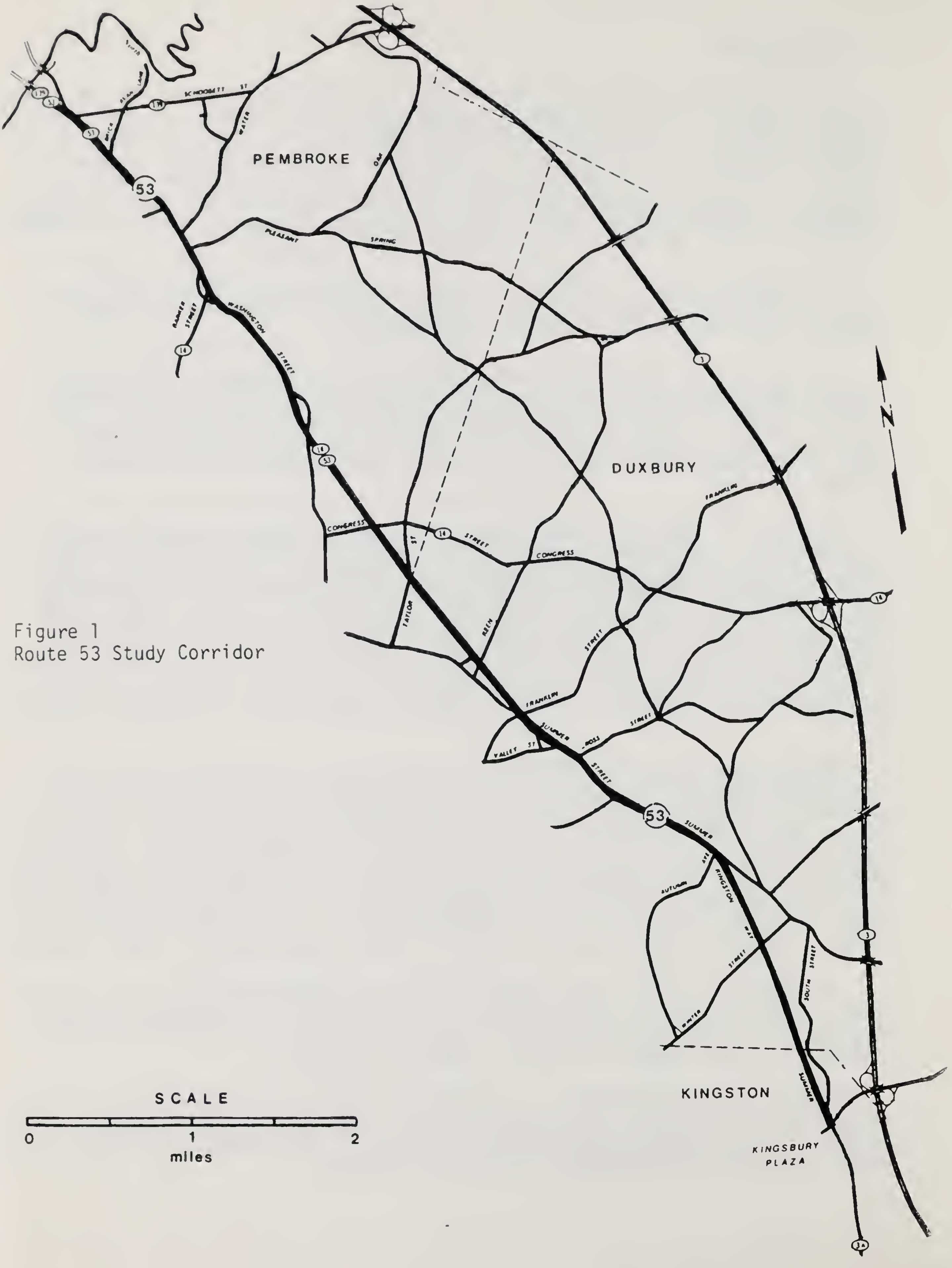


Figure 1
Route 53 Study Corridor

II. Existing and Future Conditions

A. Socio-Economic Characteristics

1. Population

Like most communities in Southeastern Massachusetts, Pembroke, Duxbury, and Kingston had little change in population until the 1950's and 60's when the area entered a new phase of development and growth. Large numbers of new residents began moving into these suburban communities from the Greater Boston Area. Factors leading to this net in-migration included:

- improved highways connecting with employment opportunities in Boston and along Route 128;
- an abundance of vacant developable land, and;
- the availability of federally insured mortgages for single family homes

From 1960 to 1980, Pembroke's population nearly tripled. During this twenty-year period, the population increased from 4,900 to 13,500 (Table 1). The population of Duxbury and Kingston also increased from 1960 to 1980, although not as dramatically as in Pembroke. Duxbury increased from 4,700 to 11,800, and Kingston grew from 4,300 residents in 1960 to 7,400 in 1980.

Future population growth in these communities is expected to continue at a rapid rate. By 1990, it is estimated that the population of Pembroke will be 16,500, Duxbury will reach 14,400, and Kingston will be over 8,900 (Table 1).

Table 1
Population Trends and Projections

	Pembroke	Duxbury	Kingston
1960	4,919	4,727	4,302
1970	11,193	7,636	5,999
1980	13,487	11,807	7,362
1990(est.)	16,548	14,400	8,912
1995(est.)	18,174	14,500	9,493

SOURCE: 1980 Census of Population, U.S. Dept. of Commerce, 1982
Old Colony Population Projections, OCPC, 1982
Regional Decline or Revival, MAPC, 1982

2. Employment and Work Trip Characteristics

The Old Colony Region and Southeastern Massachusetts as a whole can be generally characterized as a residential area having few local employment opportunities in relation to the number of employed persons residing there.

The three communities under study typify this trend as the majority of local residents commute out-of-town to their place of employment (Table 2).

For example, there were nearly 6,000 employed persons residing in Pembroke in 1980, and the total number of jobs within the community was only 1,300. Of the 1,300 local jobs, only 830 were held by residents of this "bedroom community" (Table 2). This indicates that over 5,000 work trips per day originate in Pembroke with destinations outside the town. The majority of external work trips are oriented in a northerly direction. Route 53 accommodates a substantial portion of the traffic destined for Route 3 via Route 139 in Marshfield or Route 53 in Hanover (Figure 1).

The two communities to the south, Duxbury and Kingston, exhibit similar work trip and labor force characteristics as Pembroke (Table 2). They can also be considered as "bedroom communities". However, as the distance south on Route 53 increases, the number of northbound work trips tend to access Route 3 from Interchanges in Duxbury (Route 14) and in Kingston (Route 3A) rather than from Route 139 or Route 53 in Pembroke and Hanover. This is evidenced by the decrease in traffic volumes on Route 53 from north to south.

By 1990, the population of the three communities will have increased by an estimated 7,204 persons (Table 1). The trend of commuting out-of-town to employment opportunities will continue as the majority of new residents will not be employed in their respective community. Local employment will increase, however, it will not keep pace in proportion to population growth. New employment at the local levels will be mainly in the trade and service sectors (Table 3). It is unlikely that these communities will become manufacturing centers that will attract work trips from outlying communities.

Table 2
Employment and Work Trips
1980

	Pembroke	Duxbury	Kingston
Population	13,487	11,807	7,362
Total work trips originating in Town	5,985	5,153	2,980
Work trips to Greater Boston and Rt. 128 Belt	2,420(40%)	2,183(42%)	569(19%)
Other work trips out of Town	2,735(46%)	1,647(32%)	1,832(61%)
Work trips within Town	830(14%)	1,323(26%)	579(19%)
Total local jobs	1,301	1,453	1,770

SOURCE: 1980 Urban Transportation Planning Package, U.S. Dept. of Commerce, 1984
1980 Census of Population, U.S. Dept. of Commerce, 1982
1980 Employment and Wages, Cities and Towns, Mass. Div. of Employment Security, 1983

Table 3
Employment Characteristics and Projections

	Pembroke		Duxbury		Kingston	
	1980	1990	1980	1990	1980	1990
Manufacturing	153	230	89	x	140	168
Trade	628	832	343	x	781	972
Services	278	489	273	x	84	140
Government	141	181	528	x	563	629
Other	101	167	220	x	202	267
Total	1,301	1,899(+23%)	1,453	1,600(+10%)	1,770	2,176(+46%)

SOURCE: 1980 Census of Population, U.S. Dept. of Commerce, 1982
Old Colony Employment Projections, OCPC, 1983
Employment Location in Greater Boston, MAPC, 1983

B. Physical Characteristics of the Roadway

The Study Corridor encompasses a total of 9.2 miles through the communities of Pembroke, Duxbury, and Kingston (Figure 1). Beginning at the North River on the Hanover/Pembroke Town Line, Route 53 and Route 139 (Washington Street) continue south for a distance of 0.4 miles to the intersection of Route 139 (Schoosett Street). This intersection is controlled by a flashing yellow signal for the northbound and southbound approaches of Route 53. The westbound Route 139 approach is controlled by a flashing red signal and a stop sign.

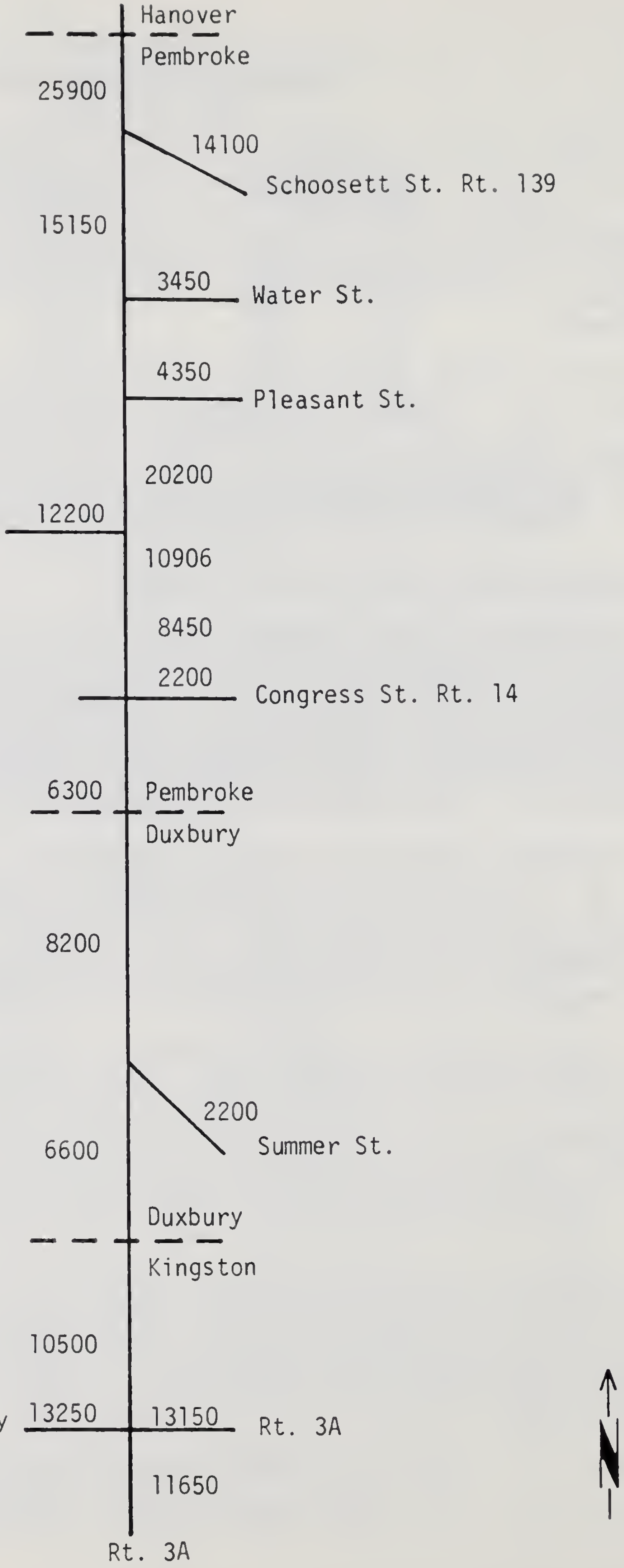
Continuing south for a distance of 1.4 miles, Route 53 is intersected by Route 14 (Barker Street), an unsignalized and channelized three-leg intersection. Route 53 is joined by Route 14 for the next 1.6 miles to the south where Route 14 turns east on Congress Street. This intersection has four approach legs with Congress Street to the west of Route 53 being a minor local road. A flashing signal controls and regulates traffic at this facility.

Route 53 enters the Town of Duxbury 0.4 miles to the south of Congress Street and is known as Summer Street. There are several minor intersecting roads for the next 2.6 miles in Duxbury where Route 53 bears to the right onto Kingston Way. This "Y" intersection is channelized and controlled by a flashing signal. Northbound vehicles on Kingston Way enter Summer Street at a 90° angle on a channelized approach and are regulated by a flashing red beacon and a stop sign. Kingston Way continues 1.2 miles south to the Kingston Town Line.

As Route 53 enters the Town of Kingston, it becomes Summer Street. Approximately 0.5 miles to the south, Summer Street is intersected by Route 3A from the south and east, marking the southern terminus of Route 53. To the east Route 3A interchanges with Route 3. A shopping plaza entrance road is located to the west of the intersection. Traffic is controlled by a fully-actuated signal system for all four approach legs.

Figure 2

ROUTE 53 CORRIDOR
AVERAGE DAILY TRAFFIC VOLUMES
1985



Source: OCPC, 1985

Drawing Not to Scale

The structural condition of Route 53 through the Study Area is in good condition and is not in need of reconstruction or resurfacing. The terrain, for the most part is level. However, there are several sections with grade changes and horizontal curves which limit visibility. The route is a two-lane bi-directional roadway with passing permitted on less than one-half of its length due to grade changes, curves, and major intersections. The two travel lanes average fifteen feet each in width. The shoulders are paved and deliniated having a two to four foot width. At a few locations, there are obstructions in close proximity to the road surface (see Chapter IV).

C. Traffic Volumes

Traffic volumes along the Study Corridor are heaviest in the northern section of Pembroke and taper off to the south in Duxbury and Kingston, with the exception of the intersection of Route 53 at Route 3A and the Kingsbury Plaza (Figure 2). At the Hanover/Pembroke Town Line, the average daily traffic (ADT) in both directions is nearly 26,000 vehicles. Beginning at the North River Bridge, Route 53 and Route 139 run together to Schoosett Street where Route 139 turns east and Route 53 continues south. Schoosett Street experiences an ADT of 14,100, while Route 53 has an ADT of 15,150.

Between Route 139 and Route 14 there are two minor intersecting roads having substantial traffic volumes, Water Street (3,450) and Pleasant Street (4,350). South of Pleasant Street traffic volumes on Route 53 increase to 20,200. This indicates that the majority of traffic on Water and Pleasant Streets is oriented in an east/south direction. Water Street is used as a bypass between Route 53 to the south and Route 139 to the east. Pleasant Street serves a residential area to the east.

Route 14 (Barker Street) has an ADT of 12,200, and south of Route 14 traffic volumes on Route 53/14 are considerably lower (8,450) than the section north of Route 14 (20,200). Traffic on Barker Street moves predominately to the north and to the west.

Further south, Route 14 turns east on Congress Street towards Duxbury. Traffic volumes on Congress Street (Route 14) are relatively low with a recorded ADT of 2,200. The Route 53 ADT is 6,300 south of Congress Street at the Duxbury Town Line.

In Duxbury, north of Summer Street, traffic volumes increase to 8,200. Route 53 continues south on Kingston Way and has an ADT of 6,600. An ADT of 2,200 was recorded on Summer Street east of Route 53.

In Kingston, Route 53 traffic volumes are significantly higher near the intersection of Route 3A and the Kingsbury Plaza. An ADT of 10,500 north of the Plaza indicates that in addition to north/south through traffic on Route 53, a substantial number of motorists are travelling between the commercial establishments in the immediate area and points south on Route 3A.

In summary, traffic volumes obtained along the Study Corridor indicate that Route 53 accommodates a variety of uses and travel patterns over its path through the three communities. Traffic volumes range from 6,600 to nearly 26,000 vehicles. The numerous intersecting streets influence traffic volumes on Route 53. Although Route 53 is a north/south highway, certain segments also handle a significant volume of east/west traffic. Due to the light to moderate commercial and residential character of land use along the corridor, it appears that Route 53 through the Study Area does not generate a substantial number of vehicle trips. Rather, Route 53 accommodates mostly through traffic.

D. Future Traffic Volumes

Future traffic volumes on Route 53 are anticipated to continue to increase at a tremendous rate, reflective of the rapid residential and commercial growth along the South Shore. To illustrate recent trends of increasing traffic volumes, a 1980 MDPW traffic count at the Hanover/Pembroke Town Line recorded an ADT of 18,260. A 1985 count by OCPC revealed an ADT of 25,900, representing a 42% increase over the five year period. Similarly, at the Pembroke/Duxbury Town Line, traffic increased from 4,300 to 6,300, a gain of 47%.

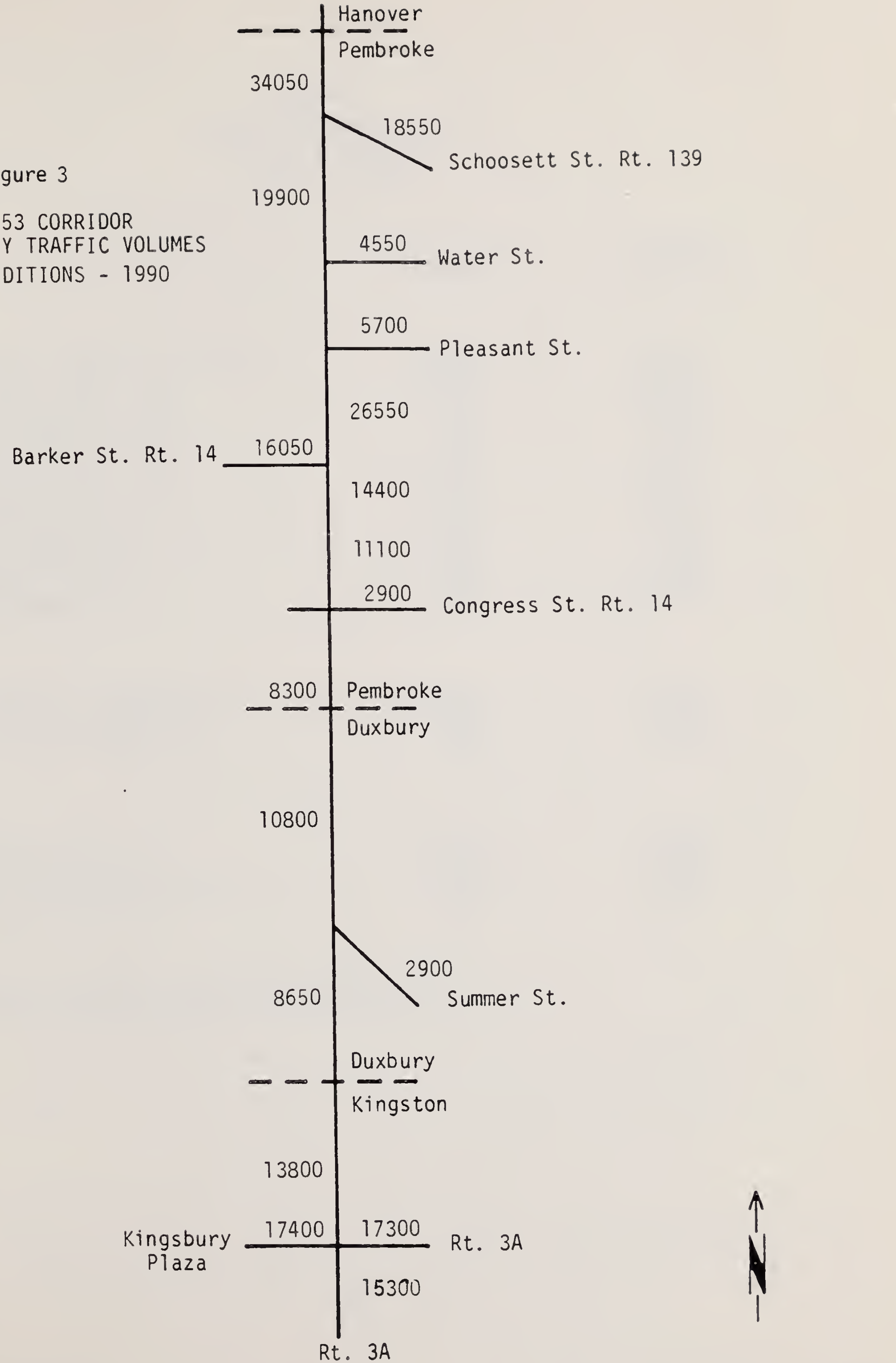
Traffic growth projections developed by OCPC for 1975 to 1995 estimate an annual increase of 5.63% for Route 53, making this corridor one of the most rapidly growing State numbered routes in the Old Colony Region. Based on an annual growth rate of 5.63%, traffic volumes at the Hanover/Pembroke Town Line are expected to exceed 34,000 by 1990. At the Pembroke/Duxbury Town Line, 1990 average daily traffic volumes will be approximately 8,300.

Figure 3 and Table 4 illustrate projected traffic volumes for 1990 conditions. It is assumed that all intersecting roadways contained in Figure 3 will experience similar growth given their proximity to Route 53. Also, it has been mentioned above that Route 53 acts as an east/west highway along certain segments. Therefore, it follows that the major intersection roadways will experience similar high growth patterns.

The determination of future traffic volumes is an important component of a traffic study. Under existing traffic volumes, a capacity or safety problem may not exist. For example, a roadway or intersection may presently operate near capacity and no congestion problems are evident. However, projected future increases in traffic may result in the facility operating above capacity with excessive congestion and delay. An analysis of both present and future congestion and safety problems will be discussed in subsequent sections of this study.

Figure 3

ROUTE 53 CORRIDOR
AVERAGE DAILY TRAFFIC VOLUMES
FUTURE CONDITIONS - 1990



Source: OCPC, 1985

Drawing Not to Scale

Table 4
Route 53 Study Corridor
Present and Future
Traffic Volumes

Location	1985 ADT[1]	1990 ADT[2]
Pembroke		
Rt. 53/139 at Hanover Town Line	25,900	34,050
Rt. 139 East of Rt. 53	14,100	18,550
Rt. 53 South of Rt. 139	15,150	19,900
Water St. East of Rt. 53	3,450	4,500
Pleasant St. East of Rt. 53	4,350	5,700
Rt. 53 North of Rt. 14	20,200	26,550
Rt. 14 West of Rt. 53	12,200	16,050
Rt. 53/14 South of Rt. 14	10,900	14,400
Rt. 53/14 North of Rt. 14	8,450	11,100
Rt. 14 East of Rt. 53	2,200	2,900
Rt. 53 at Duxbury T.L.	6,300	8,300
Duxbury		
Rt. 53 North of Kingston Way	8,200	10,800
Summer St. East of Rt. 53	2,200	2,900
Rt. 53 South of Summer St.	6,600	8,650
Kingston		
Rt. 53 North of Rt. 3A	10,500	13,800
Rt. 3A East of Rt. 53	13,150	17,300
Kingsbury Plaza West of Rt. 53	13,250	17,400
Rt. 3A South of Rt. 53	11,650	15,300

[1] See Appendix A for detailed traffic volume counts.
[2] Based on 5.63% annual growth rate, OCPC, 1981.

III. Problem Identification

A. Safety Issues

1. Introduction

There are several methods of analyzing accident data. In this study, accident information will be presented in two of these formats. The first will be the number or frequency of accidents at given locations. This method is effective in determining those specific sites where the greatest number of incidents occur. It does not, however, provide an indication of the relation between the number of accidents and traffic volumes using that particular facility.

To assess this relation, the second method used here will be the accident rate. For intersections, the accident rate is expressed in terms of the number of accidents per one million approach vehicles (MAV). For corridor segments, the rate is measured by the number of accidents per one million vehicle miles travelled (MVMT). Theoretically, an accident rate greater than 1.0 per MAV or MVMT is considered unacceptable. In many situations a rate that is marginally greater than 1.0 may not necessarily mean that an overly hazardous condition exists. A more practical application to be used in this study will be that any rate in excess of 2.0 will be deemed unacceptable, and improvement measures to rectify the situation should be implemented. All rates between 1.0 and 2.0 are considered marginal. However, it may be necessary to institute improvement measures to reduce the number of accidents, regardless of the rate.

To identify specific locations where hazardous conditions exist, accident records for the Route 53 Corridor were obtained from the Pembroke, Duxbury, and Kingston Police Departments for calender years 1983 and 1984. Included were police reports of investigated accidents and operator reports of uninvestigated accidents. This method of accident analysis is the most comprehensive means of determining which locations, if any, exhibit a safety deficiency. Also, by diagramming each accident on a base drawing of an intersection, discernable trends of specific types of occurrances can be identified. For example, an unusually high number of rear-end collisions may indicate a need for improved signing on that particular approach leg to the intersection.

Major intersections along Route 53 will be analyzed individually. The same will hold true for corridor segments which will include all minor intersections located along the defined segments in each community. The following discussion will be limited to a description of existing conditions along Route 53 and an identification of specific locations where a problem exists. In subsequent sections of this study, alternative methods to improve and/or eliminate hazardous locations will be developed. The effect of these improvements in terms of reducing the number of future accidents will also be discussed.

2. Pembroke Intersection Accidents

In Pembroke, fifty seven accidents were recorded at major intersections in 1983, and in 1984 there were fifty incidents for a two year total of 107 occurrances along the Route 53 Corridor.

For accidents occurring at major intersections, Route 53 at Route 139 experienced the greatest frequency with 54 accidents over the two year period (Table 5, Appendix B). Eleven of these accidents resulted in injuries to seventeen persons. The remaining 43 accidents were property damage only. The accident rate per million approach vehicles during the study period was 2.83, indicating a pressing need for improvement measures. Specifically, one-third of the accidents (18) at this intersection were rear-end collisions in the right turn lane of the Route 139 westbound approach to the stop sign. Eight incidents involved vehicles colliding while making conflicting turning movements. The remaining accidents included other rear-end collisions, angle collisions while maneuvering in traffic travelling in the same direction, hitting of fixed objects, and collisions with vehicles entering the travelled way from abutting retail establishments.

Table 5
Pembroke
Route 53 Study Corridor
1983-84 Accident Data and Estimated 1990 Accidents
If No Improvement Tactics Are Implemented

Inter-sections	1983 #Acc	1984 #Acc	1983-84 Rate Per MAV	Est 1990 #Acc
@ Old Whs	2	5	0.39	5
@ Schst (139)	29	25	2.92	39
@ Water	3	2	0.40	4
@ Pleasant	13	7	1.53	14
@ Barker (14)	10	8	1.24	13
@ Congress (14)	0	3	0.52	2
Total Int	57	50		77

Corridor Segments	1983 #Acc	1984 #Acc	1983-84 Rate Per MVMT	Est 1990 #Acc
Hanover to Schst	2	9	1.58	8
Schstt to Barker	14	15	1.87	21
Barker to Dux.	6	6	0.96	9
Location Unknown	5	7	N/A	8
Total Corr	27	37	1.84	46

MAV = Million Approach Vehicles
MVMT = Million Vehicle Miles Travelled

The second most hazardous location along Route 53 in Pembroke was the intersection of Route 53 and Pleasant Street (Table 5). A total of 20 accidents occurred at this site, including 6 incidents that caused 9 personal injuries (Appendix B). The remaining 14 accidents were less severe property damage-only collisions. The accident rate was 1.53 per MAV indicating a need for ameliorative action to improve safety conditions. At Route 53 and Pleasant Street, nine of the accidents over the two year period were angle collisions involving vehicles making conflicting turning movements. Five of the accidents were rear-end collisions on Pleasant Street westbound, all of which occurred in 1984.

Route 53 at Route 14 (Barker Street) proved to be the third most hazardous location in terms of total occurrences and the rate per MAV. Eighteen incidents (Table 5) at this location over the two year period included three accidents causing four personal injuries (Appendix B) and a rate of 1.24 per MAV. The accident rate at this location is marginally above the acceptable standard of 1.0 per MAV. However, improvements are still needed to eliminate this hazardous condition. At Barker Street, the majority of accidents were angle collisions during conflicting turning movements. There were only two rear-end collisions and one vehicle hit a traffic island sign.

The remaining major intersections along Route 53 all exhibited accident rates within acceptable standards during the two year period. These locations are Route 53 at Water Street (0.40), at Congress Street (Route 14) (0.52), and at Old Washington Street (0.39).

3. Pembroke Corridor Accidents

For accidents occurring at locations other than the above major intersections, Route 53 through Pembroke is divided into three specific corridor segments:

1) from the Hanover Town Line to Schoosett Street (Rt. 139),
2) from Schoosett Street to Barker Street (Rt. 14), and
3) from Barker Street to the Duxbury Town Line

These segments also include all minor intersections located along each specific segment.

Beginning with the northernmost segment of the study corridor, a two-year accident rate of 1.72 per MVTM was recorded between the Hanover Town Line and Schoosett Street (Route 139). There were a total of 12 occurrences including 4 accidents that resulted in 4 personal injuries (Table 5, Appendix B). There was no discernable trend of specific accident types or locations along this segment, although one-half of the accidents occurred during the late afternoon when traffic volumes are heaviest. By 1990, it is projected that eight accidents will occur along this segment unless improvement measures are implemented. This estimate is based on the 1983-84 accident rate and the projected future traffic volumes.

The corridor segment of Route 53 extending from Route 139 to Route 14 (Barker Street) carries significant traffic volumes and also recorded the highest accident rate (1.87 per MVMT). There were 29 accidents during the two-year period, and 8 persons were injured. Nearly a third of these accidents occurred with wet or icy road conditions. The specific location cited most frequently in the accident reports was the vicinity of the convenience store located on the east side of Route 53 to the north of Water Street. This area has several curb cuts leading to retail establishments and minor residential dead-end roads. Typical accidents involved collisions with slowing or turning vehicles. Another location cited frequently was the gas station and retail area immediately north of Barker Street. Again, collisions involved slowing or turning vehicles. By 1990 it is expected that twenty one accidents will occur along this segment under existing physical conditions.

The southernmost segment in Pembroke, from Barker Street to the Duxbury Town Line, experienced the lowest number of Route 53 accidents in Pembroke with a two-year total of 12 incidents resulting in a rate of 0.96 per MVMT. There was no identifiable trend or location of specific accident types. The low rate of occurrences indicates that this segment is relatively free from hazardous situations that would potentially cause accidents. The area has low to moderate land use and is not as developed as those segments to the north. Based on the current accident rate and projected traffic volumes, there will be an estimated nine collisions during 1990.

In addition to the accidents along the three segments described above, there were 12 other incidents on Route 53 during the study period. The exact location of these accidents was not specified in the operator reports. In total (including accidents at unknown locations), there were 64 collisions reported at non-major intersection locations in 1983 and 1984. The two year accident rate per MVMT was 1.84, indicating a need for improvement measures. Alternatives to reduce the number of occurrences will be discussed in Chapter IV of this Study. Without improvement measures in place, there will be an estimated 46 accidents at non-intersection locations during 1990, representing a 44% increase over existing conditions.

4. Duxbury Intersection Accidents

In Duxbury there were a total of 25 accidents at the four major intersections during 1983 and 1984 (Table 6, Appendix B). At the intersection of Route 53 and Franklin Street, a total of four accidents (including one personal injury) occurred resulting in a rate of 0.78 per MAV. Two of the incidents were angle collisions and two were rear-end collisions. By 1990, it is expected that three accidents will occur under existing conditions. Due to the low rate per MAV, it is assumed that the facility is not in need of accident reducing improvement measures, although improvements would reduce the accident potential.

The intersection of Route 53 at Valley and Cross Streets experienced the highest number of accidents (8) and the highest rate per MAV (1.44) of all intersections in Duxbury (Table 6). Three of the incidents resulted in injuries to five persons (Appendix B). These personal injury accidents included one head-on, one rear-end, and one loss of control collision. Four of the other accidents were angle collisions involving turning vehicles. This site is a four leg intersection with the minor approaches staggered and not aligned to a 90° angle. There is also a retail establishment on the west side of Route 53.

This alignment may have cause confusion for motorists negotiating turns in the area. It is projected that six accidents will occur here in 1990 without improvement measures in place.

Table 6
Duxbury
Route 53 Study Corridor
1983-84 Accident Data And Estimated 1990 Accidents
If No Improvement Tactics Are implemented

Intersections	1983 #ACC	1984 #ACC	1983-84 Rate PER MAV	EST 1990 #ACC
@ Franklin	2	2	0.78	3
@ Val/Crs	2	6	1.44	6
@ Kg Way	5	2	1.23	5
@ Winter	3	3	1.18	4
Total Int	12	13		18

Corridor Segments	1983 #ACC	1984 #ACC	1983-84 Rate PER MAV	EST 1990 #ACC
Pembroke to Kg Way	7	7	1.10	10
Kg Way to Kingston	1	1	0.38	1
Total Corr	8	8	0.89	11

MAV = Million Approach Vehicles
MVMT = Million Vehicle Miles Travelled

The intersection of Route 53 at Kingston Way is a three-leg facility with Kingston Way intersecting Summer Street at an approximate 30° angle (Figure 1). Five accidents were reported at this location during the two-year period, including two personal injuries and one pedestrian involvement. The personal injury accidents occurred as motorists lost control and hit fixed objects. Also, three northbound vehicles hit the traffic island while turning left to Summer Street. The accident rate of 1.23 is marginally above acceptable standards, and without corrective action five accidents are projected for 1990.

The final major intersection on Route 53 in Duxbury is located at Kingston Way and Winter Street. From points to the west, Winter Street is used as a connection to Route 53 and Route 3A to Route 3. There were six incidents over the two-year period of which three resulted in six personal injuries (Table 6, Appendix B). All of the total accidents involved vehicles entering Route 53 and colliding at an angle with through vehicles. The accident rate was marginally acceptable at 1.18. However, the nature and severity of the involvements indicates that there is a hazardous condition in need of corrective measures. Otherwise, it is expected that four similar accidents will occur in 1990.

5. Duxbury Corridor Accidents

For accidents occuring at locations other than the above specified intersections, the Route 53 corridor through Duxbury is divided into two separate segments:

1) from the Pembroke Town Line to Kingston Way, and
2) Kingston Way from Summer Street to the Kingston Town Line

These segments will also include all minor intersections located along each sepcific segment.

The first segment, Summer Street from Pembroke to Kingston Way, had a two-year total of 14 accidents yielding a rate per MVMT of 1.10 (Table 6, Appendix B). Of the 14 accidents, one-half resulted in injuries to 7 persons, indicating that when accidents do occur, they are severe in nature. Also, four of the personal injury accidents occurred under icy conditions. This section of Route 53 is unlighted, and six of the total accidents occurred after dark. There was no discernable trend of specific accident locations as the incidents were dispersed over the 2.6 mile length of Route 53 (Summer Street). Despite a marginal accident rate, the severity of collisions and the resulting personal injuries indicate a pressing need for improvements. By 1990, it is estimated that ten accidents will occur along this segment unless corrective measures are taken to improve conditions.

The second segment, Kingston Way from Summer Street to the Kingston Town Line, was relatively free from accidents with 2 property damage only incidents and a rate per MVMT of 0.38. This 1.2 mile section of Route 53 is lineal and traffic volumes are low compared to other segments of the study corridor.

6. Kingston Intersection Accidents

In Kingston, there is one major intersection on Route 53, marking the southern terminus of the study corridor. At this point, Route 53 is intersected by Route 3A from the south and east. Kingsbury Plaza is located to the west. This facility is the only intersection on the study corridor where traffic movement is controlled by a signal system. There were a total of 15 accidents over the study period (Table 7, Appendix B), all of which were property damage only accidents. Four of the involvements were angle collisions during conflicting east/west movements. The respective signal phase for east/west movement does not allow for protected left turns. In contrast, the north/south phasing has a protected left, and consequently there were only two collisions involving north or southbound left turns. The two-year accident rate was a marginally acceptable 0.92 per MAV. However, the problem of angle collisions involving eastbound and westbound left turns should be corrected.

By 1990, it is projected that over 11 million motorists will approach the facility, and without some corrective measures there will be an estimated 11 accidents per year by 1990.

7. Kingston Corridor Accidents

The Route 53 corridor through Kingston is only 0.5 miles in length. This relatively short section experienced nine accidents (2.55 per MVMT) over the two-year period, of which 2 caused personal injury (Table 7, Appendix). The majority of accidents involved vehicles entering or leaving the travelled way and colliding with through moving vehicles. The restaurant driveway on the east side of Route 53 directly north of Route 3A was cited in three of the reports. The remaining accidents showed no pattern or trend, so the specific cause of these accidents is difficult to identify. By 1990, it is expected that under existing conditions six accidents will occur along Route 53 in Kingston.

Table 7
Kingston
Route 53 Study Corridor
1983-84 Accident Data and Estimated 1990 Accidents
If No Improvement Tactics Are Implemented

Inter-Section	1983 #ACC	1984 #ACC	1983-84 Rate PER MAV	EST 1990 #ACC
@ RT 3A	8	7	0.92	11

Corridor Segment	1983 #ACC	1983 #ACC	1983-84 Rate PER MVMT	EST 1990 #ACC
Duxbury to RT 3A	6	3	2.55	6

MAV = Million Approach Vehicles
MVMT = Million Vehicle Miles Travelled

B. Operating Conditions

1. Introduction

The operation of a roadway or an intersection is dependent on a number of variables. These influential factors can be generally summarized in two specific categories: 1) roadway geometry, and 2) the composition of traffic using the facility. Geometrics are the fixed dimensional, non-varying characteristics of a roadway, while traffic composition is the number and type of vehicles actually using the facility. Composition can fluctuate by time of day, day of week, or month of year.

The geometrics of a roadway, i.e. width, number of lanes, vertical alignment horizontal curves, signal timing, etc, determine a relatively stable value known as capacity. The actual number and composition of vehicles using the facility is measured against the capacity to produce a value known as the volume to capacity (v/c) ratio. Theoretically, a high v/c ratio is indicative of unacceptable operating conditions which may be marked by congestion and delay for motorists. On the other hand, a relatively low v/c ratio indicates that the facility can accommodate existing traffic volumes with no apparent congestion problems.

To determine or quantify the operating conditions of an intersection or roadway, several reliable mathematical models and methodologies have been devised. The analyses contained in this study will be based on selected methods of determining the relationship of volume and capacity as well as delay.

Level of Service (LOS) analysis is a commonly used method of quantifying taffic flow through an intersection or roadway accommodating various traffic volumes. It is a qualitative measure of volume to capacity.

Level of Service is defined and ranked as follows:

Level of Service "A" - stable flow, low volumes and high speeds; most drivers can select own speed.

Level of Service "B" - stable flow, speed and movement restricted slightly by traffic.

Level of Service "C" - stable flow, speed and movement controlled by traffic; service volume is used for design of urban highways and intersections.

Level of Service "D" - approaching unstable flow; low speed.

Level of Service "E" - unstable flow, low varying speeds; volumes at or near capacity.

Level of Service "F" - forced flow, low speed, volume above capacity; stoppages.

Levels of Service A, B, and C are considered acceptable, while LOS D, E, and F are unacceptable indicating a need for improvement measures

2. Route 53 at Route 139

The unsignalized intersection of Route 53 at Route 139 is the most heavily used facility along the study corridor, and consequently it experiences the lowest levels of service and the greatest amount of congestion. The methodology used to evaluate the operating conditions of this intersection is based on certain critical movements which must be accommodated. For three-leg unsignalized intersections, these critical movements are:

- Right turns from the minor street
- Left turns from the major street
- Left turns from the minor street

The ability with which these movements can be accommodated is based on a number of factors including primarily opposing traffic volumes and minimum "gaps" in conflicting traffic that motorists will accept. Other maneuvers, such as through movements on the major road and right turns from the major road are not considered critical movements, although they do influence and limit the number of critical movements.

During the morning peak hour, the intersection of Routes 53 and 139 operates at an acceptable level of service (Table 8). Left turns from Route 139 experience a delay problem. However, very few vehicles actually turn left from Route 139, and the low level of service is not considered a major problem. Left turns from Route 53 Southbound to Route 139 present a problem during the noon hour. A substantial number of vehicles execute this maneuver. The same holds true throughout the afternoon and into the afternoon peak hour.

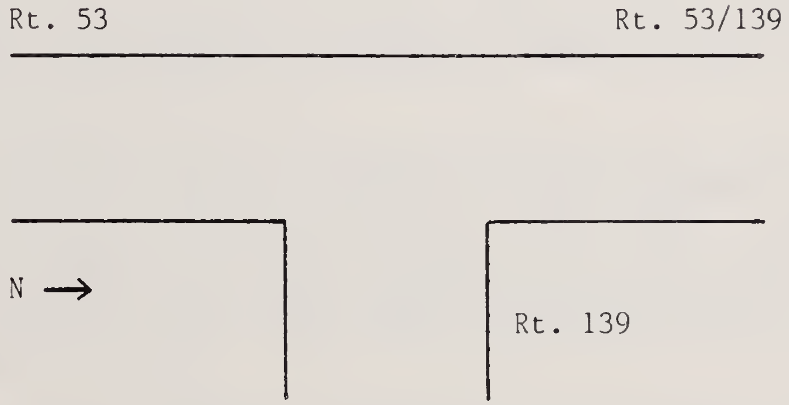
The congestion problem on the southbound Route 53/139 approach is attributable to a high traffic volume and a high percentage of left turns to Route 139 (Appendix C). As left turning vehicles wait for an acceptable gap in opposing traffic, motorists that desire to drive straight through on Route 53 southbound are delayed by the left turning vehicles stopped at the intersection. This southbound approach leg has only one travel lane, and through vehicles are unable to pass left turning vehicles. At the time of field observation, southbound approach vehicles were queued for a distance of several hundred feet.

Another congestion problem at this intersection is the westbound Route 139 approach. The majority of vehicles turn right to Route 53/139 from a separate right turn lane with a wide turning radius. Although this type of movement normally is made with a minimum of conflict from opposing vehicles (a merge with through traffic that can be accomplished at a shorter gap), extensive right turn vehicle queues are typical on Route 139. This is due to the high volume of westbound traffic on Route 139 and northbound traffic on Route 53.

For left turning vehicles from Route 139, excessive delay is encountered due primarily to opposing traffic (southbound through, lefts, and northbound

Table 8
Level of Service Summary
Route 53 at Route 139
Existing Conditions (Unsignalized)

	1985 Volume	1985 LOS	1990 Volume	1990 LOS
AM Peak Hour:				
Right Turns From Rt.139	326	B	429	D
Left Turns From Rt. 53	259	A	341	C
Left Turns From Rt. 139	31	D	41	E
Noon Hour:				
Right Turns From Rt.139	377	B	496	E
Left Turns From Rt. 53	673	E	885	E
Left Turns From Rt. 139	43	E	57	E
PM Peak Hour:				
Right Turns From Rt.139	492	C	647	E
Left Turns From Rt. 53	560	D	736	E
Left Turns From Rt. 139	141	E	185	E



1. Transportation Research Circular 212, Transportation Research Board, 1980. (See Appendix C for detailed Worksheets)

throughs) rather than a high volume of vehicles attempting this maneuver.

By 1990, traffic volumes at this intersection are expected to increase by about 31%, an annual growth rate of 5.63%. As a result of this increase, the vehicle demand on this facility will become greater. Unless physical improvements are in place by 1990, extreme congestion on all approaches will occur throughout most of the entire day (Table 8).

Alternatives to alleviate the existing as well as the future anticipated congestion problems at Route 53 at 139 will be discussed in Chapter IV.

3. Route 53 at Route 14

The intersection of Route 53 at Route 14 (Barker Street) is similar to Route 53/139 in that it is a heavily used three-leg unsignalized facility. From Table 9, a congestion and delay problem at this site is caused by a high number of vehicles headed east on Route 14 and then turning left onto Route 53 northbound. This type of left turn from a minor approach road is difficult for operators to negotiate. They must wait for an acceptable gap in conflicting through traffic on Route 53. Vehicle queues for left turning vehicles on the Route 14 approach are typical throughout both the morning and afternoon peak periods.

Alternatives for improving the overall operating condition of Route 53 at Route 14 will be explored in Chapter IV of this study.

4. Route 53 at Route 3A

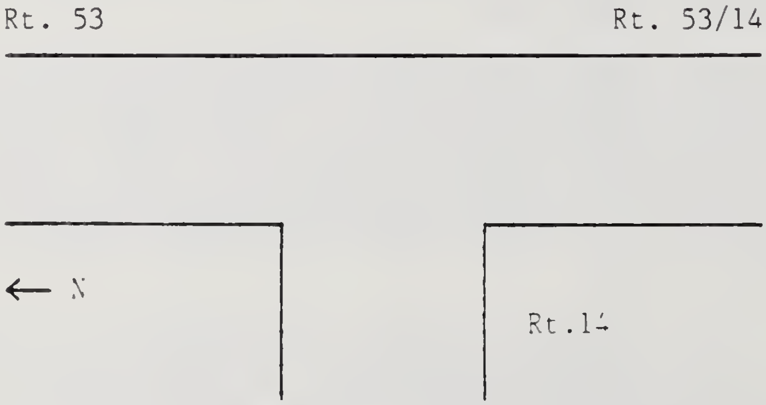
The signalized intersection of Route 53 at Route 3A in Kingston marks the southern terminus of the study corridor. This facility is heavily used for access to Route 3 from Kingston, for local trips to Kingsbury Plaza, and for northbound trips from Kingston via Route 53. Nearly 25,000 vehicles pass through this intersection per day.

The signal system controlling traffic flow at this location is fully-actuated and functions according to demand. Electro-magnetic loop detectors located under the road surface monitor the vehicle demand. Those approaches having a greater demand receive more "green time", while those approaches with little demand receive less. A fully actuated system allows the most efficient use of an intersection, particularly when the vehicle demand fluctuates per approach throughout the day.

The existing signal phasing (Appendix C) provides for protected left turns on the northbound and southbound approaches. In other words, a protected left turn has a green arrow and is not made through opposing traffic. However, on the eastbound and westbound approaches, left turns are not protected but permissive. A permissive left turn is made through opposing traffic. This tends to limit the capacity of the movement and also creates a potential for angle collisions with oncoming vehicles.

Table 9
Level of Service Summary
Route 53 at Route 14
Existing Conditions (Unsignalized)

	1985 Volume	1985 LOS	1990 Volume	1990 LOS
AM Peak Hour:				
Right Turns From Rt. 14	24	A	32	A
Left Turns From Rt. 53	34	A	45	A
Left Turns From Rt. 14	398	E	523	E
Noon Hour:				
Right Turns From Rt. 14	60	A	79	A
Left Turns From Rt. 53	47	A	62	A
Left Turns From Rt. 14	275	E	362	E
PM Peak Hour:				
Right Turns From Rt. 14	31	A	41	A
Left Turns From Rt. 53	31	A	41	A
Left Turns From Rt. 14	399	E	525	E



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1. Transportation Research Circular 212, Transportation Research Board, 1980. (See Appendix C for detailed Worksheets)

To measure the operating conditions of Route 53 at Route 3A, methodology from Chapter 9 of the 1985 Highway Capacity Manual has been applied. The new methodology takes into account a variety of factors including lane width, number of lanes, lane group configuration, approach grades, bus stops, parking maneuvers, and signal phasing and timing. The result of this analysis is two-fold; 1) an estimation of the volume to capacity (v/c) ratio for each approach, and 2) a level of service determination based on the average delay per approach vehicle. A lower v/c ratio and average delay per vehicle are considered more favorable indicators.

Table 10 summarizes the operating conditions of Route 53 at Route 3A. Overall, the volume to capacity ratio and the level of service for the facility are acceptable. However, specific congestion and delay problems do exist, particularly left turns from the Route 3A westbound approach. Given the relatively high volume of westbound left turns, coupled with an unprotected phase, the left turn lane of this approach is presently operating at full capacity. The result is a long average delay per approach vehicle.

Other than westbound left turns, all remaining east/west movements operate at very favorable conditions. However, these remaining east/west movements are receiving considerably more "green time" than is needed. The additional or maximum green time assigned to the east/west phase is based on the nigh westbound left turn demand. The result is underutilized green time for the other east/west movements.

On the northbound and southbound approaches there is a protected phase for left turns only, while through and right-turn movements are controlled by one of three possible phasing schemes which is selected automatically according to demand (Appendix). The level of service analysis presented in Table 10 reveals that the northbound and southbound movements are marginally acceptable and are operating at a high vehicle to capacity ratio.

By 1990, traffic volumes will have increased substantially (Table 4, Figure 3), and subsequently the demand on this intersection will become greater. From Table 10, the 1990 estimated demand for left turns from Route 3A westbound will far exceed capacity under the existing signal timing and phasing. All of the other respective movements at this facility will operate at a higher vehicle to capacity ratio and a lower level of service. The result will be a greater total delay per approach vehicle when compared to present conditions.

These less than acceptable conditions at the Route 53/3A intersection could be improved by a re-phasing of the signal cycle. This would increase the traffic carrying capacity of the entire intersection. In particular, westbound left turns need a protected phase. This alternative will be discussed in detail in Chapter IV.

Table 10
Route 53 at Route 3A
Summary of Existing & Future Conditions
PM Peak Hour

	1985		1990	
	V/C Ratio	LOS(Delay)	V/C Ratio	LOS(Delay)
Eastbound				
LT	0.25	B	0.41	B
TH	0.30	A	0.40	B
RT	0.31	A	0.41	A
Westbound				
LT	1.00	E	1.84	F
TH	0.30	B	0.39	B
RT	0.07	A	0.09	A
Northbound				
LT	0.66	D	0.87	D/E
TH	0.48	C	0.64	C
RT	0.79	D	1.04	F
Southbound				
LT	0.67	D	0.88	D/E
TH	0.74	C/D	0.97	E
RT	0.73	C/D	0.96	E
	Critical V/C Ratio	LOS(Delay)	Critical V/C Ratio	LOS(Delay)
Total Intersection	0.86	C	1.48	F

SOURCE: OCPC Turning Movement Counts, 1985
Highway Capacity Manual, Transportation Research Board, 1985
(See Appendix for detailed worksheets)

IV. Recommended Improvement Tactics

A. Introduction

In Chapter III, a number of traffic flow and safety shortcomings were identified for major and minor intersections and corridor segments along Route 53. Analyses of these problem areas were based on collected field data including mechanical traffic volume counts, manual turning movement counts at intersections, and research of accident files at the local police departments. In addition, projections of future traffic conditions and related problems were developed.

This Chapter will examine each location that has been determined as a problem area. On a site-by-site basis, alternative improvements to alleviate these shortcomings will be presented.

Following the individual site analysis, a suggested course of action for community involvement in project implementation will be provided. Recommended tactics are divided into a short range interim solution and a long range final solution. The interim plan consists of minor projects such as signing improvements, while the final plan involves more costly capital expenditures such as signalization and lane widening.

B. Route 53 at Route 139

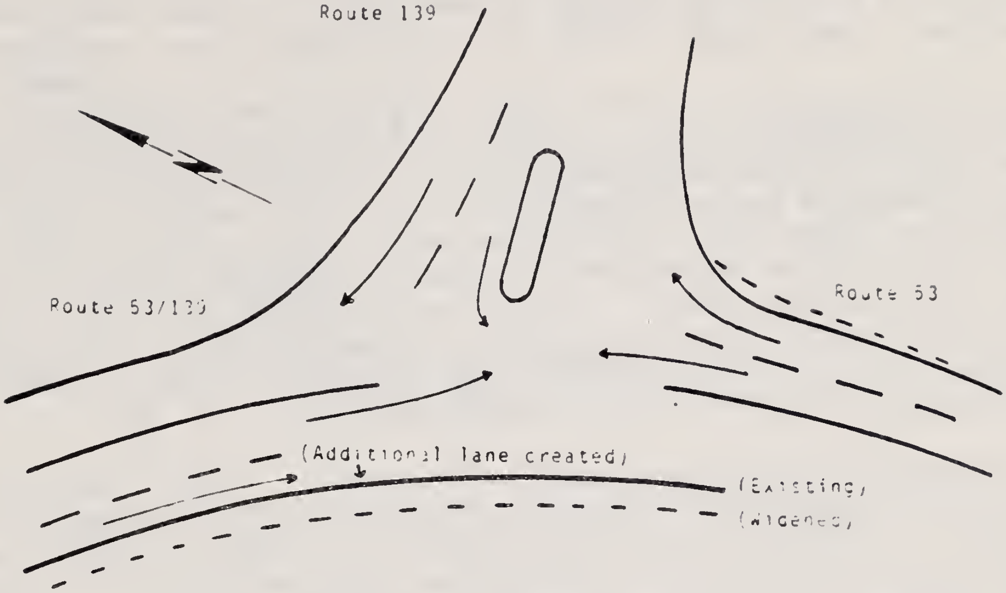
There are two viable means of improving the level of service and reducing congestion and delay at the unsignalized intersection of Route 53 at 139. These are: 1) road widening to create additional approach lanes on Route 53 (southbound and northbound), and 2) installation of a traffic control signal. The most effective method would be a combination of both lane addition and signalization. The merits of each alternative are presented below.

Lane additions on the southbound and northbound approaches of Route 53 would improve the flow of through traffic, particularly on the southbound approach. As noted above, southbound left turn vehicles are forced to wait for an acceptable gap in opposing traffic before completing this maneuver. As a result of being a one lane approach, southbound through vehicles must wait until these left turn queued vehicles have cleared the intersection.

If the southbound approach were widened on the west side of the intersection (Figure 4), a right hand passing lane would be created. (Road widening at this location would require a minor right-of-way taking and the relocation of a utility pole.) This would enable through vehicles to clear the intersection without being delayed by left turning vehicles. The drawback to this scenario is that the left turning vehicles would still be conflicting with left turning vehicles from the westbound approach and northbound through vehicles.

On the northbound Route 53 approach, the majority (92%) of approach vehicles throughout the day drive straight through the intersection (Appendix A). Right turning vehicles are few (8%). However a right turn maneuver is in

Figure 4
Route 53/139
Alternative Lane Geometry



Note. Drawing not to scale

conflict with a high number of left turns from the opposing southbound direction. Widening of the northbound approach would create storage space for right turns. Although the impact of this alternative would not be great, it would still serve to enhance operating conditions (and safety).

The westbound Route 139 approach presently has two approach lanes, for right and left turns, respectively. There is no need for geometric improvements at this location as each lane has ample storage area and the right lane turning radius appears to be sufficient.

The above geometric improvements and lane addition would improve operating conditions and reduce congestion at Routes 53 and 139. However, there would still be considerable delay and safety problems because of conflicting turning movements. At present, there is no regulation of traffic flow other than a flashing red and yellow beacon and a stop sign on Route 139. Vehicles execute the desired maneuvers according to acceptable gaps in opposing traffic. Certain turning movements such as right turns require shorter gaps and are easier for motorists to complete. Other types of maneuvers (left turns in particular) require a longer acceptable gap and cause greater delay (and safety problems).

The installation of a control signal would regulate traffic flow through the facility and would permit vehicles to complete their respective maneuvers unencumbered by opposing traffic. Traffic signal installation at Routes 53 and 139 would reduce total delay while simultaneously improving safety conditions. Warrants for the installation of traffic signals, as defined in the Manual on Uniform Traffic Control Devices[1] must be met prior to signalization. The Warrants are based primarily on minimum traffic volumes throughout the day or on accident experiences. Routes 53 at 139 meets these requirements (Appendix D).

A fully actuated traffic control signal system would provide optimum operating conditions at this location. A fully actuated system works on demand where a specified maximum "green time" is assigned to those movements having a greater number of approach vehicles. Approaches having a lesser demand would receive less green time. Electro-magnetic loop detectors under the road surface monitor the vehicle demand and are used to determine the length of each green phase of the signal cycle. The outstanding benefit of such a system is that the overall traffic carrying capacity of the facility is optimized. This is especially effective at locations such as Routes 53 and 139 where demand varies per approach at different time periods throughout the day.

Figure 5 presents an example of how traffic signal installation and signal phasing could serve to eliminate conflicting turning movements at Routes 53 and 139. It should be noted that there are a number of traffic engineering considerations that must be incorporated into the design of a signal system. These considerations include geometrics, sight distances, grade changes, etc. Figure 5 is merely intended to demonstrate how a signal could provide an orderly system of traffic flow and how congestion and delay could be reduced.

During each of the three respective signal phases, vehicles could complete their maneuver in an orderly means. Simultaneously, movements from other approaches that do not conflict with the protected movement would also be assigned green time. For example, during Phase 1 when the southbound approach is moving through and left, the westbound approach would be assigned a right turn green arrow. When the westbound approach (Phase 3) receives its right and left phase, northbound right turns would be permitted.

This example of signal phasing is predicated on the assumption that the southbound and northbound approaches each have two approach lanes. If lane additions were not implemented, this type of signal phasing would not be practical. Otherwise, a three phase system with one phase for each approach would have to be devised. This would not be as optimal as the example provided. Therefore, the best alternative for improving traffic flow (and safety) would be a combination of road surface widening, lane addition, and installation of a fully actuated traffic signal.

To estimate the effect of signalization and its relation to eliminating congestion and delay, methodology from Chapter 9 of the Highway Capacity Manual[2] has been applied to the intersection of Routes 53 at 139. The new method takes

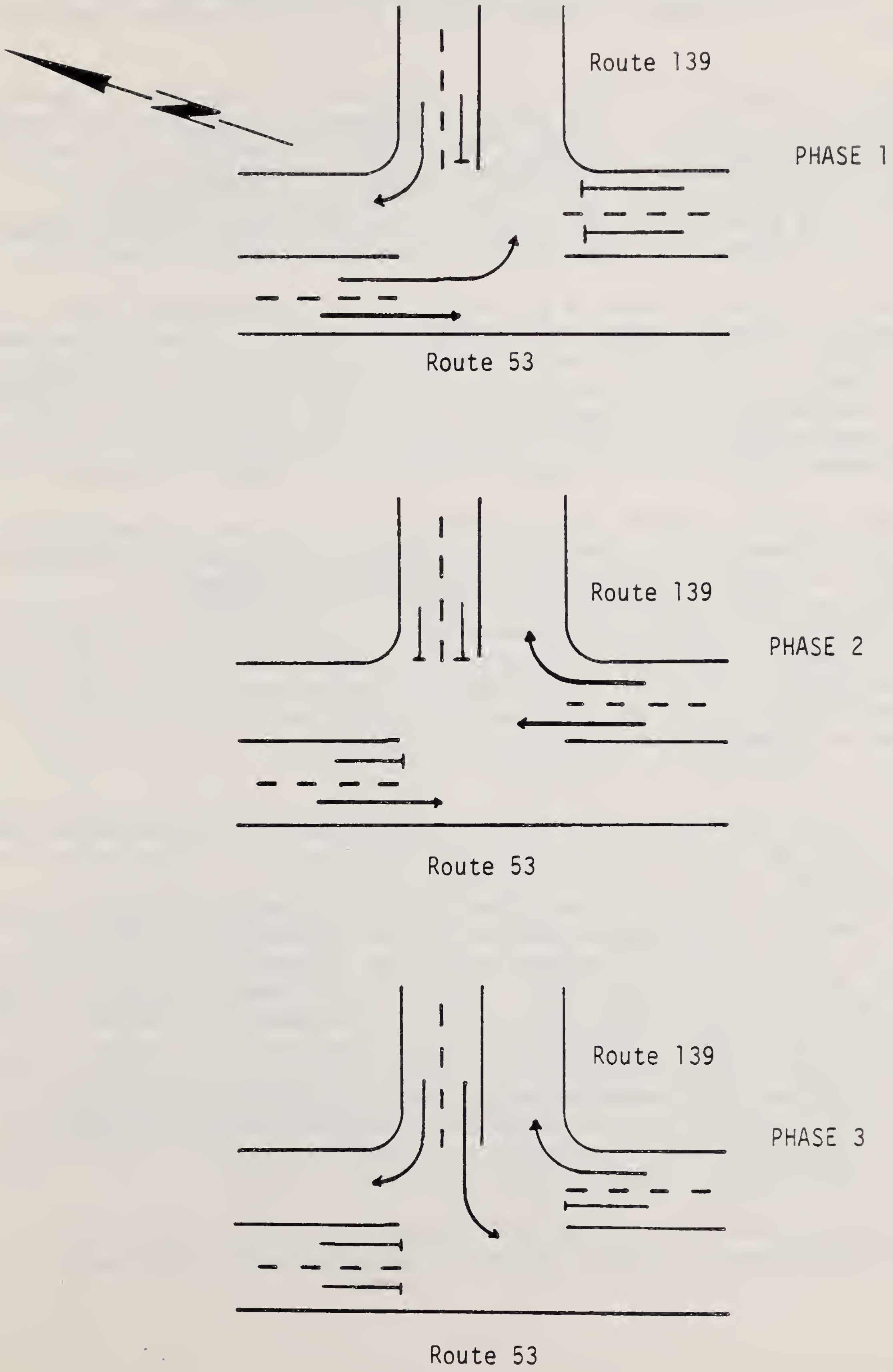
[1] Federal Highway Administration, 1978

[2] Transportation Research Board, 1985

Figure 5

Route 53 at Route 139

Alternative Phasing for Signal Installation



Note: drawing not to scale

into account a variety of factors including lane width, number of lanes, lane group configuration, approach grades, bus stops, parking maneuvers, and signal phasing and timing. The result of this analysis is twofold; 1) an estimation of the volume to capacity (v/c) ratio for each approach, and 2) a level of service determination based on the average delay per approach vehicle. A lower v/c ratio and average delay per vehicle are considered more favorable indicators.

For the intersection of Route 53 at 139, capacity and level of service are summarized in Table 11. This analysis is based on geometric improvements (Figure 4) as well as signalization (Figure 5) of the facility. All of the approach lanes and respective protected turning movements would operate at reasonable volume to capacity (v/c) ratios. The greatest demand and consequently the highest v/c ratio would be for southbound left-turns from Route 53 to Route 139 during the afternoon peak when traffic is heaviest.

In terms of level of service and delay, all of the movements would be within acceptable standards, except for westbound left turns. However, the demand on this movement is relatively low and not considered to be an outstanding problem. More importantly, this theoretical scenario illustrates one feasible method of improvement for accommodating a very high number of conflicting turning movements throughout the intersection as a whole. Overall, it is a vast improvement over the existing unsignalized conditions (see Chapter 3).

By 1990, traffic volumes using this facility will have increased at a enormous rate (Appendix A). The result will be an even greater vehicle demand and a higher v/c ratio. It is possible that the above geometric improvements and signal phasing may not be able to accommodate the higher traffic volumes at acceptable efficient levels. If this occurs, it would be necessary to permit right turns on red or to re-phase the signal system to all limited conflicting movements. These measures would serve to increase capacity. However, by allowing right turns on red or limited conflicting movements, minor negative safety connotations may result.

Under the safety issues discussion, it was noted that the accident rate of Route 53 at 139 was not within acceptable standards. In particular, there were a high number of rear end collisions in the right turn lane of the westbound approach. Normally, the installation of a traffic signal will tend to increase rear-end collisions. However, in this situation on Route 139, the unusually high number of rear-end collisions is not the result of vehicles stopping at the designated stop line. Rather it is caused in part by sudden, abrupt stops by motorists attempting to enter the stream of northbound traffic. Signalization would serve to eliminate motorist confusion and unsurety when negotiating a right turn onto Route 53. The conflict with northbound vehicles would be eliminated, and the potential for rear-end collisions would be reduced. Also, signal phasing as presented in Figure 4 would eliminate a significant number of angle collisions on the remaining approaches, because venicles would no longer be maneuvering through opposing streams of traffic.

The above alternatives for improving safety conditions (widening and signalization) are in reality projects that could not be implemented

Table 11
Route 53 at Route 139
Summary of Level of Service Analysis
With Signalization and Geometric Improvements
PM Peak Hour

	1985			1990		
	Approach Volume	V/C Ratio	LOS (Delay)	Approach Volume	V/C Ratio	LOS (Delay)
Westbound						
LT	139	.58	D	185	.78	
TH						
RT	494	.60	B	647	.74	
Northbound						
LT						
TH	403	.78	C	533	1.03	E
RT	35	.05	B	43	.06	B
Southbound						
LT	562	.83	C	736	1.09	F
TH	716	.56	A	944	.74	A
RT						

	1985		1990	
	Critical V/C Ratio	LOS (Delay)	Critical V/C Ratio	LOS (Delay)
Total Intersection	.78	B	.87	D

Key: V/C = Volume to Capacity
LOS = Level of Service in terms of delay per approach vehicle
LT = Left turn movements
TH = Through movements
RT = Right turn movements

SOURCE: OCPC Turning Movement Counts, 1985
Highway Capacity Manual, Transportation Research Board, 1985
(See Appendix for detailed worksheets)

within a short time period. Therefore, to gain immediate results from safety improvements, a Transportation System Management (TSM) program should be implemented until the capital improvements are constructed. At this location, "intersection warning" and "stop ahead" signs represent a viable low cost TSM program that would reduce the number of accidents, particularly the westbound rear-end collisions. Also pavement edge markings should be maintained to provide motorists with a more clearly defined path of travel.

C. Route 53 at Route 14

The unsignalized intersection of Route 53 at Route 14 (Barker Street) experiences congestion problems similar to those of Route 53 at Route 139. The predominant vehicle flow pattern is between Route 14 to the west and Route 53 to the north (Figure 1, Appendix A). Accordingly, the peak hour demand is greatest for eastbound left turns from Route 14 and southbound right turns from Route 53 (Table 9).

Under the existing unsignalized conditions, eastbound vehicles on Route 14 turning left onto Route 53 northbound experience excessive delay and congestion (Table 9). Drivers must wait for acceptable gaps in through traffic on Route 53 beford they can execute this maneuver. Due to the heavy demand for left turns and a significant number of opposing vehicles, the capacity of the movement is exceeded by the actual traffic volumes, and this condition will worsen in the future.

At Routes 53 and 14, the installation of a traffic control system would provide safe orderly movement of vehicles through the facility and would reduce congestion and delay. Signal phasing could be designed to eliminate conflicting movements in a similar manner as described for Route 53 at 139 (Figure 4). The overall critical volume to capacity ratio would be within acceptable standards (Table 12). Excessive delays and long vehicle queues in the eastbound left turn lane would be eliminated. All other movements would operate within acceptable standards, the exception being northbound left turns. Very few northbound vehicles turn left onto Route 14, and this is not considered a major problem. However, left turn storage space should be provided for these vehicles. The easterly side of Route 53 needs minor widening to create a safe right hand passing lane for northbound vehicles.

An added benefit of signalization is that conflicting movements would be minimized, reducing the potential for angle collisions. During 1982 and 1983, the majority of accidents of Route 53 and 14 involved vehicles entering or exiting from Route 14 and colliding with a through vehicle on Route 53 (Appendix B). This type of angle collision has historically shown to be less severe, resulting in property damage only. However, it is a problem in need of correction, and the most feasible solution appears to be signalization.

On a short term temporary basis, safety and operating conditions could be enhanced by the installation of intersection warning and stop ahead signs. These Transportation System Management improvements could be implemented more quickly than signal installation and would provide immediate benefits.

Table 12
Route 53 at Route 14
Summary of Level of Service Analysis
With Signalization and Geometric Improvements
PM Peak Hour

	Approach Volume	1985 V/C Ratio	LOS (Delay)	Approach Volume	1990 V/C Ratio	LO (De
Eastbound						
LT	399	.61	B/C	525	.80	
TH						
RT	31	.04	B	41	.05	
Northbound						
LT	31	.20	D	41	.27	D
TH	249	.32	B	368	.47	B
RT						
Southbound						
LT						
TH	393	.68	C	517	.89	[illegible]
RT	445	.40	A	585	.52	[illegible]

	1985 Critical V/C Ratio	1985 LOS (Delay)	1990 Critical V/C Ratio	1990 LOS (Delay)
Total Intersection	.59	B	.79	B/C

Key:
V/C = Volume to Capacity
LOS = Level of Service in terms of delay per approach vehicle
LT = Left turn movements
TH = Through movements
RT = Right turn movements

SOURCE: OCPC Turning Movement Counts, 1985
Highway Capacity Manual, Transportation Research Board, 1985
(See Appendix for detailed worksheets)

D. Route 53 at Route 3A

In Kingston, at the intersection of Route 53 and 3A, the majority of traffic flowing through the facility operates at an acceptable level of service. The exception is the Route 3A westbound approach. During afternoon peak hours there are a substantial number of vehicles heading west from Route 3 and turning south via Route 3A (Figure 1). Under the existing conditions, analysis of this intersection indicates that these left turns are at full capacity, resulting in excessive delay per approach vehicle (Table 13). East/west movements do not enjoy the benefit of a protected left turn phase which would increase left turn capacity. Further, if a maximum green time is assigned to east/west movements on the basis of westbound left turn demand, there is unused green time for other east/west movements, resulting in inefficient operation of the intersection as a whole.

To remedy this situation, signal phasing improvements are needed. A protected east/west left turn lead phase in advance of the remaining east/west movements would increase the overall capacity of east/west movements and lower the volume to capacity ratio (Table 13, Appendix C). In other words, the facility could accommodate more east/west left turns per hour, and less green time would be wasted on other east/west movements. North/south movements could be allocated more green time, improving its respective traffic carrying capacity.

As a further benefit to this alternative signal phasing plan, a number of angle collisions would be reduced. By allowing a percentage of left turning vehicles to execute their maneuver without conflict from opposing traffic, the probability of angle collisions is reduced.

E. Minor Intersections

1. Introduction

In addition to the preceeding three major intersections along the Route 53 Study Corridor, there are a number of other locations where traffic control improvements are needed. These improvements are for the benefit of facilitating traffic flow and/or eliminating a potentially hazardous condition. Certain minor intersecting roadways along Route 53 such as Pleasant Street in Pembroke and Winter Street in Duxbury (Figure 1) are now experiencing safety problems. As residential growth spawns additional traffic, conditions will worsen. These narrow intersecting streets are in need of upgrading to accommodate present and future traffic volumes. Improvements may require either a large capita expenditure for construction or less costly Transportation Systems Management (TSM) projects that can be implemented quickly and inexpensively.

Based on standards set by the American Association of State Highway and Transportation Officials[1] (AASHTO) and the Institute of Traffic Engineers[2] (ITE), the following discussion will be a general description of how minor intersections may be upgraded. Included will be considerations for geometric layout and traffic control devices for "T", "Y", and four leg intersections, all of

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[1] A Policy on Design of Urban Highways and Arterial Streets, AASHTO, 1973
A Policy on Geometric Design of Highways and Streets, AASHTO, 1984.

[2] Transportation and Traffic Engineering Handbook, ITE, 1976.

Table 13
Route 53 at Route 3A Kingston
Summary of Intersection Analysis
PM Peak Hour

		Existing Phasing		Alternative Phasing			Existing Phasing		Alternative Phasing	
	1985 Volume	1985 V/C Ratio	1985 LOS	1985 V/C Ratio	1985 LOS	1990 Volume	1990 V/C Ratio	1990 LOS	1990 V/C Ratio	1990 LOS
Eastbound										
LT	109	0.25	B	0.20	B/C	143	0.41	B	0.27	B/C
TH	217	0.30	B	0.53	C	285	0.40	B	0.69	C
RT	293	0.31	A	0.40	B	385	0.41	A	0.52	B
Westbound										
LT	322	1.00	E	0.60	C	423	1.84	F	0.79	C/D
TH	215	0.30	B	0.52	C	283	0.39	B	0.69	C
RT	55	0.07	A	0.09	B	87	0.09	A	0.12	B
Northbound										
LT	210	0.66	D	0.54	C	276	0.87	D	0.71	C/D
TH	161	0.48	C	0.39	C	212	0.64	C	0.55	C
RT	227	0.79	D	0.47	B/C	299	1.04	E	0.62	B/C
Southbound										
LT	212	0.67	D	0.54	C	279	0.88	D	0.72	C/D
TH	246	0.74	C/D	0.60	C	323	0.97	D	0.79	C/D
RT	210	0.73	C/D	0.44	B/C	276	0.96	D	0.57	B/C
Total Intersection	2488	0.86	C	0.61	C	3271	1.40	F	0.80	C

Key: V/C = Volume to Capacity
LOS = Level of Service in terms of delay per approach vehicle.
LT = Left turn movements
TH = Through movements
RT = Right turn movements

SOURCE: OCPC Turning movement counts, 1985
Highway Capacity Manual, Transportation Research Board, 1985
(See Appendix C for detailed worksheets)

which are the key elements for efficient and safe operation.

Basic T intersections can vary greatly in size, shape, and degree of channelization. The basic form of an unchannelized T intersection is presented in Figure 6-A. This type of unchannelized intersection is suitable for junctions of minor and local roads or where minor roads meet with more important roadways. A plain T intersection is usually sufficient for carrying light volumes of traffic.

Where design speeds are high and turning movements are sufficient in number to increase hazards such as on Route 53, additional areas of road surface may need to be provided, as shown in Figures 6-B, C, and D. An additional lane or flaring of the intersection will allow for improved maneuverability. The use of auxiliary lanes increases capacity and reduces hazards caused by turning vehicles.

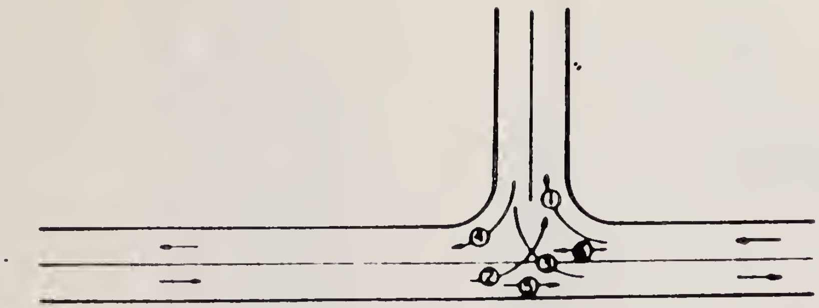
Figure 6-B shows the flaring of the through roadway to provide a speed-change lane and storage area for right turns. This type of arrangement is applicable where the right turns from the major roadway are substantial and the left turns from the opposite approach are minor.

Left turns from the through roadway to the minor street are particularly hazardous because the turning vehicles must slow down or stop before a gap in the opposing traffic enables them to execute the turn. The provision of an auxiliary lane or right hand passing lane (Figure 6-C) will enable and encourage through vehicles to maneuver around the slower moving left turn vehicles. This type of arrangement is useful when there are substantial left turns and through movements on the major roadway, and opposing right turn movements are minor.

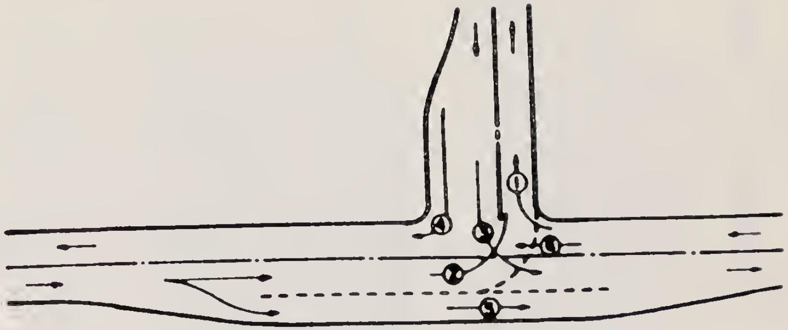
In the situation where the capacity of a two lane highway at an intersection is taxed by high traffic volumes and where a signal is required, it may be necessary to provide the lane arrangement presented in Figure 6-D. In this case auxiliary lanes are located on each major approach. In rural areas, this condition may require converting the through highway to a divided section through the intersection. Another possibility is the addition of an auxiliary lane on one or both sides of the minor road as shown in Figure 6-C.

A "Y" type of intersection is quite similar to a T intersection in that there are three approach legs. The difference is that a Y intersection has the minor street joining the through roadway at less than a 90° angle (Figure 7). The same general principles and considerations for T intersections apply to the Y configuration. Auxiliary turning lanes to and from the minor approach can be incorporated into the design of a Y intersection. The same holds true for right hand passing lanes on the through roadway.

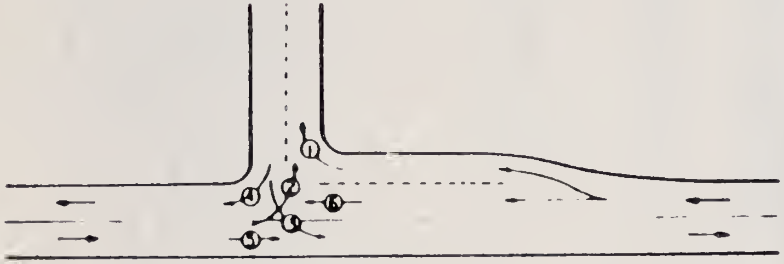
The major consideration for Y intersections is that the minor road be aligned as close as possible to a 90° angle (Figure 7-A). This type of alignment enables motorists to execute safe orderly movements over a more clearly defined path. In particular, the safety aspects of left turns to and from the minor



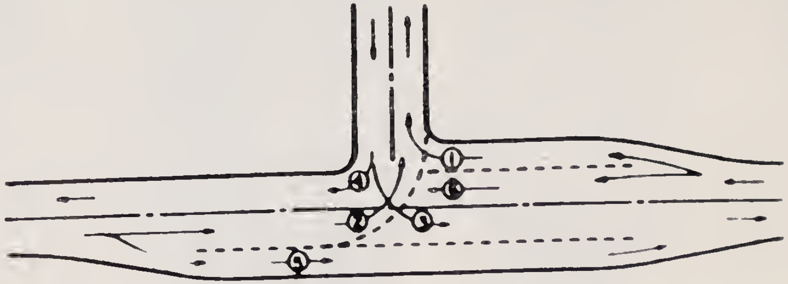
PLAIN "T" INTERSECTION
-A-



'T' INTERSECTION (WITH RIGHT HAND PASSING LANE)
-C-



T' INTERSECTION
(With Right Turn Lane)
-B-

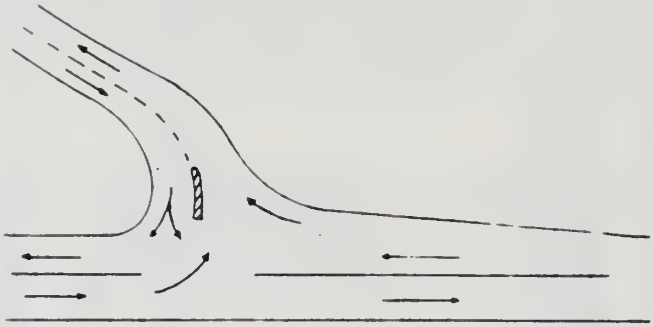


'T' INTERSECTION (WITH RIGHT HAND PASSING LANE AND RIGHT TURN LANE)
-D-

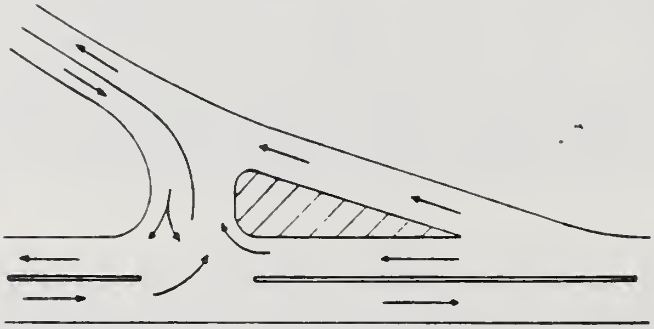
Figure 6
Design Considerations for
T Intersections

Source: A Policy on Geometric Design of Highways and Streets, AASHTO, 1984, pp. 824-5.

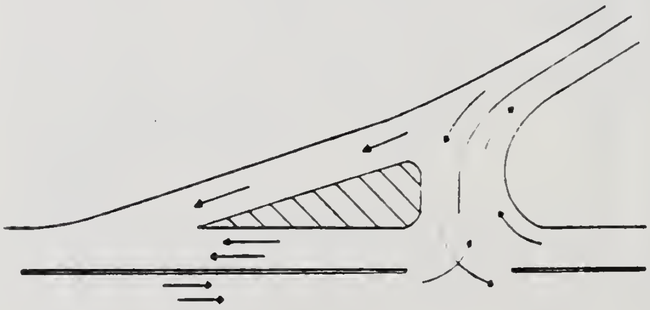
Figure 7
"Y" Intersections



A. "Y" Intersection Without Right Turn Island



B. "Y" Intersection With Right Turn Island From Major Roadway

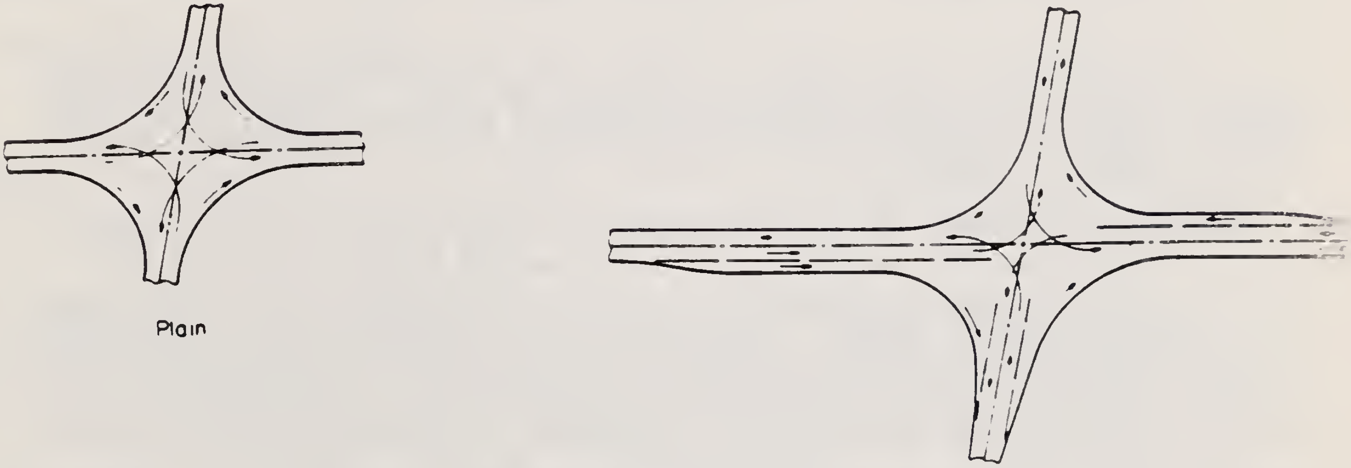


C. "Y" Intersection With Right Turn Island From Minor Roadway street are enhanced.

The right turn lane to or from the connecting road can be designed as a one-way lane separated by a channelizing island (Figure 7-B, C). Left turning vehicles from the through roadway should be prevented from improperly using the one-way right turn lane through the installation of a narrow physical barrier or medium strip on the major road. Where a medium strip is not feasible on the through roadway, the minor right turn lane should be eliminated as shown in Figure 7-A.

Four leg intersections in their simplest form are unchannelized and are controlled by stop signs on two, three, or four of the approach legs. Figure 8-A depicts a plain four leg intersection. The intersection is generally not more than 30° from the normal, allowing for the alignment of the intersecting streets to range from 60° to 120°. This type of simple arrangement is suitable for intersections with low volumes of traffic or where there is a minor crossing of a through roadway with few turning movements from the major approaches. The corners are rounded to accommodate turning vehicles.

Figure 8
Four Leg Intersections



Plain

Flared

Source: A Policy On Geometric Design Of Streets And Highways, AASHTO, 1984, p.835.

To improve the capacity of through and turning movements, the approach legs to the intersection can be flared or an auxiliary lane can be added (Figure 8-B). By providing storage areas for left or right turning vehicles, through vehicles are able to pass slow-moving or stopped vehicles preparing to turn. In areas where speeds are high and intersections are infrequent such as on Route 53, left turns from the through roadway can be particularly hazardous.

Flaring of an intersection is generally similar on opposite legs, and the arrangement will depend on relative volumes and types of traffic.

In addition to the geometric layout of "T", "Y", and four leg intersections, there are a number of other traffic control considerations that are applicable to all types of intersections. Each individual intersection has its own set of unique characteristics, and the design of each is to a considerable extent dependent on traffic demands, land use, topography, and economic and environmental considerations. The following list includes a number of design principles that should be followed when consideration is given to intersection design:

1. Separate roadways (channelization) can be provided for both left and right turning vehicles, thereby reducing conflicts and eliminating complex driver decisions in the intersection area.

2. Preference should be given to intersection approaches and movements having the heaviest and fastest flow of traffic to minimize overall delay. Movements with a lesser demand should be controlled by a stop or yield sign, depending on the prevailing conditions.

3. Excessive wide-open intersection areas cause driver confusion and inefficient operation. Large areas are inherent in skewed and multiple approach intersections. Channelization should be employed when intersections have excessive areas of conflict.

4. The design of the curb or turning radius depends on the size and turning paths of vehicles using the facility. In general, a wider radius increases capacity and enhances safety conditions for all types of vehicles.

5. Sight distance at an intersection affects the potential to avoid collisions for vehicles starting from the stopped position on the minor approach as well as vehicles on the through roadway operating at the design speed. The minimum sight distance for all approaches should be designed to avoid these conditions. Sight obstructions caused by horizontal alignment, grade changes, or other physical barriers such as vegetation should be controlled wherever possible.

6. Ideally, an intersection should be entirely at-grade. At those locations where vertical at-grade alignment does not exist, it may be necessary to make grade adjustments to improve operating and safety conditions.

Based on this general description design of traffic control considerations for rural intersections, specific locations on the Route 53 Study Corridor will be discussed site-by-site with reference to the above text. Recommended improvement tactics are provided for those locations cited as having a safety deficiency. In addition, other locations are recommended for improvements to eliminate potentially hazardous conditions.

2. Route 53 at Old Washington Street

This intersection is located directly south of the North River (Figure 1). Old Washington Street joins Route 53 at an approximate 45° angle from the north forming a "Y" intersection. The two-year accident rate for this location was an acceptable 0.39 per MAV. However, there is a need for intersection improvements to remove a potential safety hazard.

Vehicles travelling south on Old Washington Street and turning left (south) on Route 53 face a potentially hazardous situation as they are aligned at an acute angle. This maneuver is nearly impossible for large trucks which are unable to see to their right (north) before entering Route 53. Sight distance is reduced because of the angle of approach.

The recommended improvement tactic for Old Washington Street at Route 53 is to align the minor approach leg to a 90° angle and install a channelizing island as depicted in Figure 7-B. All vehicles travelling south on Old Washingto and turning left (south) on Route 53 would approach at a 90° angle. Northbound vehicles on Route 53 turning right onto Old Washington would have a separate one-way channelized turning lane. These are the two most common movements at this location. There are relatively few southbound left turns from Route 53 to Old Washington Street or southbound right turns from Old Washington to Route 53.

3. Route 53 at Water Street

Route 53 at Water Street is an unsignalized three-leg "T" intersection with Water Street being the minor leg approach to Route 53 (Figure 1). Water Street traffic is controlled by a stop sign. Traffic volumes on Water Street are significant (3,500 per day) as this road serves as an ad-hoc by-pass between Route 53 and Route 139 to the east.

From the collected mechanical traffic count data for the intersection (Appendix A), it appears that there are sufficient traffic volumes on the minor and major approaches to meet the minimum requirements for signal installation. (See MUTCD Warrants, Appendix D.) However, this may not be best for the overall flow of traffic on Route 53 as the continuous movement of vehicles would be interrupted. It is not believed that an excessive delay problem exists at this location although there may be a slight delay problem for westbound vehicles on Water Street during the afternoon peak hour.

The two year accident rate at this location was an acceptable 0.40 per MAV (Table 5). This indicates that there is no pressing need for improvement measures. However, it would be in the communities' best interest to upgrade the intersection by installing improved intersection warning signs. Also, minor widening of the Water Street turning radii and the creation of a right hand passing lane on Route 53 southbound (Figure 6-C) would make the facility safer for motorists.

4. Route 53 at Pleasant Street

Pleasant Street intersects Route 53 and primarily serves a residential area to the east. This T intersection is controlled by a stop sign on the minor leg.

The two year accident rate at Route 53 and Pleasant Street was a marginally acceptable 1.53 per MAV (Table 5). Of the twenty accidents over the study period, one-fourth resulted in personal injuries to nine individuals, indicating that improvement measures are needed. Collisions at this location can be severe. Vehicles approaching Route 53 from Pleasant Street are entering a faster flowing stream of traffic, and this maneuver is difficult.

As described in the above text for Water Street, it appears that the intersection of Route 53 at Pleasant Street has sufficient traffic volumes to warrant traffic signal installation (Appendices A, D). This may not, however, be best for overall traffic flow along Route 53. A more practical alternative is geometric changes to the facility. The major Route 53 approaches should be widened to create a southbound right hand passing lane and a northbound right turn lane (Figure 6-D). The Pleasant Street approach should be widened with the turning radii increased. Finally, improved intersection warning signs should be installed on all approaches.

5. Route 53 at Route 14 (Congress Street)

Located 0.4 miles north of the Pembroke/Duxbury Town Line (Figure 1), this four leg intersection is controlled by a flashing yellow/red signal mounted on an overhead mast arm. From the north, Routes 53 and 14 run together to Congress Street where Route 14 turns east into Duxbury. Route 53 continues south to Duxbury and Kingston.

This intersection was relatively free from accidents over the two year study period. As evidenced by the low traffic volumes on Congress Street (Figure 4), the majority of vehicles using the facility are travelling north/south with few turning movements. Recommended improvements for Route 53 at Congress Street include improved sight distance on the minor approach legs (Congress Street). Vegetation on the minor approaches tends to limit sight distance. Also, turning radii could be widened with no apparent right-of-way takings or relocation of utility poles.

6. Route 53 at Franklin Street

Franklin Street in Duxbury intersects Route 53 approximately one mile south of the Pembroke Line. Traffic volumes are relatively low on the minor approaches which primarily serve residential areas on either side of Route 53.

The 1983-84 accident rate at this location was an acceptable 0.78 per MAV (Table 6). However, minor improvements such as improved signing are needed to reduce the potential for accidents. In the future, it maybe necessary to widen the travel lane width and turning radii of the minor approach legs.

7. Route 53 at Valley and Cross Streets

In Duxbury, the intersections of Route 53 at Valley and Cross Streets are located 1.1 miles south of Pembroke (Figure 1). This location is actually two three leg intersections and are located approximately 400 feet apart. A small retail area is located directly south of Valley Street on the westerly side of Route 53. As one enters this area from the north, there is a sharp vertical drop near Valley Street followed by a vertical rise to Cross Street.

Valley and Cross are considered as a single intersection or location in this study due to a high number of accidents occurring at and between these two roadways. (Table 6, Appendix B). Also, accidents at this site can be severe. Of eight incidents during 1983 and 1984, three accidents resulted in injuries to five persons.

To improve safety and operating conditions, it is recommended that Valley Street be aligned to a 90° angle as shown in Figure 7-A. It would not be necessary to add a channelizing island for right turns to Route 53. At Cross Street, the approach should be widened and aligned to a 90° angle. Also, sight distance from Cross street needs to be improved by removing vegetation and by grading of minor land bluffs adjacent to Route 53. Finally, improved intersection warning signs and flashing beacons would improve safety conditions.

8. Route 53 at Summer Street and Kingston Way

This three leg Y intersection is located approximately 1.2 miles from the Kingston Town line (Figure 1). It has a one-way right turn lane for southbound vehicles and a channelized 90° approach for northbound left turns (similar to Figure 7-B). Traffic is also controlled by a stop sign for northbound vehicles on Route 53. There is also a post mounted flashing red and yellow beacon.

The two year accident rate for this intersection was marginally acceptable standards, aside from one pedestrian involvement (Table 6, Appendix B). Recommended improvements include upgraded signing on all approaches and replacement of the existing post mounted flashing beacon with a more powerful mast arm mounted unit. These tactics will enhance safety and operating conditions.

9. Route 53 at Winter Street

Winter Street intersects Route 53 approximately one-half mile north of Kingston (Figure 1). From the west, Winter Street is used by Duxbury and Kingston residents for access to Routes 53, 3 and 3A for north and southbound destinations.

During 1983 and 1984, there were a total of six accidents, three of which resulted in injury to six persons (Appendix B). Although the accident rate was marginally acceptable (1.18 per MAV, Table 6), there is still a need for safety improvements because of the severity of collisions at this remote unassuming intersection. All of the accidents were angle collisions involving vehicles turning from the minor approaches and colliding with faster moving through vehicles on Route 53.

It is recommended that the minor approach legs be widened with improved turning radii and sight distances. Also, street lighting should be upgraded, and intersection warning signs and flashing beacons should be installed.

F. Access Controls

Access controls are another important facet to be considered in improving safety conditions. Along the Route 53 corridor, there are a number of fairly new or recently expanded retail establishments. When this type of growth occurs at spot locations, its total effect tends to be unnoticed until a stretch of the roadway turns into a strip development. Because of no local planning policies to control access to these establishments at the on-set of the growing process, the result is unsafe conditions caused by unlimited access.

To substantiate this claim, the accident rate along Route 53 in Pembroke was highest on the segment extending from Route 139 to Barker Street (1.87 per MAV). This segment also contains more retail establishments than any other along the study corridor. The operator's and police accident reports frequently described the nature of collisions as involving a vehicle turning into or out of a retail establishment.

For example, a restaurant, a convenience store, and a retail specialty shop may all be located side-by-side along a major roadway in a rural area. Generally, there is no curbing or curb cuts to the establishments. Motorists are then offered a wide open space in which to leave the roadway and enter the retail area. This tends to confuse other motorists as they are unsure of the specific location where a vehicle is going to turn off the roadway onto the private property. What is needed in this situation is a well defined access point or driveway. All movements to and from the retail area should be restricted to the access point, and improper movements should be prevented through the use of physical barriers. For small retail areas such as those on Route 53, it would not be difficult or expensive to implement these improvements

On a larger scale, a parcel of land adjacent to a long segment of the roadway may be developed for industrial and warehouse use with a large number of employees and delivery trips generated by the facility. Rather than having each firm with its own driveway, it may be beneficial to have each individual plant connected to a service road running parallel to the highway. The service road would then have limited access points to the roadway. This setup would need to be implemented during the early stages of planning and prior to construction. It may not be feasible to implement this policy in an older industrial area. However, due to the nature of Route 53 being rural with an abundance of developable land, an access policy at the local level should be enacted by each community for both large industrial areas and smaller retail areas.

G. Other Safety Issues

Route 53 can be characterized as a rural lineal roadway relatively free from adjacent land uses that tend to inhibit traffic flow, particularly in Duxbury where Route 53 is not as developed as those segments to the north and south. There are, however, several minor intersecting roadways and numerous private driveways with access to Route 53. This poses a problem as vehicles entering Route 53 are starting from a stopped position and merging with a faster flowing main stream of traffic.

At an open public meeting held in Duxbury to review and discuss the findings of the Draft Route 53 Corridor Study, local residents expressed a concern for excessive vehicle speeds on Route 53. Their feeling was that posted speed limit signs were inconsistent or missing and that most motorists fail to comply with speed regulations. Further, they attributed unacceptable accident rates to excessive speeds of through vehicles colliding with other vehicles entering or leaving Route 53. This factor of excessive speed was impossible to determine as a cause of accidents during the research of police and operators' accident reports, and the local concerns cannot be substantiated within the scope of this Study. They are, however, real issues in need of further investigation. Speed limit enforcement policies and compliance must be enacted at the local level. The recommendations contained in the study suggest an improvement of motor vehicle control devices, both physical and regulatory.

V. Recommended Implementation Plan

A. Introduction

Based on the identification of existing and anticipated future traffic problems along Route 53, feasible alternatives were developed and analyzed with regard to specific measures that would improve safety and operating conditions. To develope a definitive plan of action for the Towns of Pembroke, Duxbury, and Kingston to follow in initiating these improvements, a Short Range Plan for immediate implementation and a Long Range Plan for future implementation are presented in the following text. Also, a discussion of how the Towns may procure federal and state funding assistance for highway improvement projects is presented.

B. Short Range Plan

A number of alternative improvement measures presented in this study fall under the category of Transportation System Management (TSM). These projects generally do not require extensive capital expenditures. TSM improvements are low-cost traffic management tactics such as pavement markings, signing, and traffic signal timing adjustments. Further, TSM improvements can usually be implemented without long time delays for planning, design, and funding procurement that are typical of capital intensive projects such as major road reconstruction or traffic signal installation.

In considering a short range plan for immediate implementation, TSM improvements represent a viable means of enhancing traffic safety and operating conditions. However, if a traffic or safety issue poses a serious problem in need of immediate corrective measures that cannot be solved through TSM solutions, it may be necessary to include capital improvements as part of the short range plan to expedite the capital project.

Table 14 summarizes transportation improvement projects recommended for a Short Range Plan for immediate implementation. These improvements consist primarily of low-cost TSM programs such as improved signing at intersections.

C. Long Range Plan

The following long range recommended plan is designed to meet the needs of the Route 53 Corridor through Pembroke, Duxbury and Kingston by the horizon year 1990, barring any unforeseeable events that would place a greater demand on the corridor than those projected for the horizon year. Long range improvements consist primarily of capital intensive construction projects. Classifying these improvements as long range projects does not infer that action need not be taken until 1990 for implementing these projects. Capital improvements often require several years for planning, design, and procurement of funding. Therefore, action should be taken immediately to implement these projects. Project funding and sources will be discussed in the final section of this Chapter.

Table 14 also includes transportation improvement projects recommended for

Table 14
Summary of Short Range and Long Range Improvement Plan for Route 53

Intersection	Short Range Plan	Long Range Plan	Derived Benefit
Pembroke: @ Old Washington	Improve Signing	Realignment to a 90° angle, Channelization	Safety
@ Rt. 139	Improved Signing	Widening of Rt. 53, Signalization	Safety, Traffic Fl
@ Water	Improved Signing	Widening, Geometrics	Safety
@ Pleasant	Improved Signing	Widening, Geometrics	Safety
@ Rt. 14 (Barker)	Improved Signing	Widening of Rt. 53, Signalization	Safety, Traffic F
@ Rt. 14 (Congress)	Improved Sight Distance	Widening of Minor approaches, Geometrics	Safety
Duxbury: @ Franklin	Improved Signing and Sight Distance	*Widening of Minor approaches, Geometrics	Safety
@ Valley/Cross	Improved Signing and Sight Distance	*Widening Geometrics, Installation of Flashing Beacons	Safety
@ Kingston Way	Improved Signing, Upgrading of Existing Flashing Beacon		Safety
@ Winter	Improved Signing and Sight Distance	Widening Geometrics, Installation of Flashing Beacon	Safety
Kingston: @ Rt. 3A	Rephase Traffic Signals for E/W Left turns		Safety, Traffic Fl
Corridor Segments			
All towns:	Policy to Control and Limit Site Access, Improved Signing, Enforced speed limits	Improved Lighting	Safety

*The need for these improvements may be marginal although they would reduce the potential for accidents.

final implementation by the Towns of Pembroke, Duxbury and Kingston. These improvements consist of capital intensive programs that should serve to meet the needs of the corridor into the foreseeable future. It is recommended that these recommendations are in place by 1990.

Another important transportation issue affecting the three communities in the study area as well as the entire Southeastern Massachusetts reion is the restoration of commuter rail service direct to Boston. Aside from the overall economic benefits to the region and the reduction in motor vehicles on Route 3 and the Southeast Expressway, Route 53 would also experience an improvement in peak hour traffic flow. If commuter rail stations were located in Hanson, Kingsto and Plymouth, a significant number of Boston bound work trips would be diverted from Route 3 and Route 53 to rail boarding points to the west. Therefore, it is recommended that the communities of Pembroke, Duxbury, and Kingston encourage and support the legislation for the restoration of commuter rail service.

D. Project Implementation and Funding

The foregoing recommended improvements fall into two categories; 1) Transportation Systems Management (TSM) programs, and 2) Capital Programs. TSM improvements are generally low cost programs that could be funded by the community. Capital programs will usually involve state and federal assistance. Local funds may also be needed, depending on the type of project.

For both Capital and TSM programs, assistance is available primarily through Massachusetts Department of Public Works (MDPW), the agency responsible for the allocation of state and federal funds for highway projects.

Normally, the project implementation and funding process begins with the community's chief elected official requesting MDPW to take action on a project. If the project is approved by MDPW, the Department will determine the source of funding for the project. A project may be eligible for federal and/or state funding, depending on the nature of the project. The community may also be responsible for a portion of the project cost. MDPW will most likely request the town to fund the engineering and design costs for a project. This usually represent about 10% of the total project cost. The balance is paid througn federal and/or state funding sources.

An important point to remember is that the project will be competing on a state-wide basis for limited state and federal funds. Therefore, it is in the community's best interest to demonstrate strong local support, commitment of design funds, and persistent communication with MDPW for project implementation. MDPW will generally expedite those projects which have strong local support. (Note: for a more detailed explanation of the highway project funding process, refer to the Transportation Funding Guide for the Old Colony Region, OCPC, 1984).

The community also has the option of funding the entire project with local funds. For lesser improvements such as TSM programs, this may be the best course of action. However, a community must obtain approval from MDPW for any project that will alter the existing traffic control devices on a public way. For example, channelization, road widening, or regulatory signing installation are subject to MDPW approval.

On Route 53 in the three communities of study, MDPW is the responsible administrative agency for maintenance and improvements. The jurisdiction for Route 53 falls under the MDPW District 7 Office. However, this should not prevent the local communities from indicating and requesting a needed improvement project. Project impetus can come from the town or the MDPW District Office.

In the situation where a group of local residents are affected directly by operating conditions on Route 53 (i.e. vehicles perceived to exceed posted speed limits), the best course of action is for a consolidation and formalization of ideas. Resident concerns should be presented to the local Board of Selectmen, who through the proper chnnels, consult with MDPW on possible improvements such as lowering of speed limits. Strong local support is essential to this process. Also, thecommunity's Regional Planning Agency is available for technical assistance in these matters.